PART 3 of 3

TECHNICAL SPECIFICATION AND DRAWINGS

BEST VALUE PROCUREMENT
PROPOSAL REQUIREMENTS

Project Name: North Regional Library Refurbishment
1315 Lowry Ave North
Minneapolis, MN 55411

Contract Number: 5014R9

Project Number: 1004474

Release Date: December 23, 2019

PART 2 – TECHNICAL SPECIFICATIONS AND DRAWINGS

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   a. Conditions of the Contract
   b. General Requirements
   c. Technical Specifications

2. Project Drawings
NORTH REGIONAL LIBRARY REFURBISHMENT
HENNEPIN COUNTY

PROJECT MANUAL
For Bid and Construction

VOLUME 2

December 23, 2019

BTR Commission Number: 1745

BENTZ/THOMPSON RIETOW, INC.
Architects
900 Second Ave. So., Suite 400
Minneapolis, MN 55402
(612) 332-1234

BKBM ENGINEERS
Civil Engineer
6120 Earle Brown Dr #700
Minneapolis, MN 55430
763-843-0420

BKBM ENGINEERS
Structural Engineer
6120 Earle Brown Dr #700
Minneapolis, MN 55430
763-843-0420

GAUSMAN & MOORE
Mechanical and Electrical Engineers
1700 MN-36 # 700
Roseville, MN 55113
651-639-9606

DAMON FARBER
Landscape Architects
401 N 2nd Ave., Suite 410
Minneapolis, MN 55401
612-332-7522

LERCH BATES
Elevator Consultant
11670 Fountains Drive, Suite 200
Maple Grove MN 55369
612-790-3924
ARCHITECT
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Architect under the Laws of the State of Minnesota.

Print Name: ANN VODA AIA, CID, LEED® AP BD+C, BENTZ/THOMPSON/RIETOW, INC.

Signature: Ann Voda

Date: December 23, 2019   License # 15699

CIVIL ENGINEER
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the Laws of the State of Minnesota.

Print Name: JOEL MAIER, PE, BKBM, Inc.

Signature: Joel W. Maier

Date: December 23, 2019   License # 19181

LANDSCAPE ARCHITECT
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Landscape Architect under the Laws of the State of Minnesota.

Print Name: TOM WHITLOCK. PLA. DAMON FARBER

Signature: Tom Whitlock

Date: December 23, 2019   License #26292

STRUCTURAL ENGINEER
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the Laws of the State of Minnesota.

Print Name: RONALD J. LAMERE, PE, BKBM, Inc.

Signature: Ronald J. Lamere

Date: December 23, 2019   License # 19180
MECHANICAL ENGINEER

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the Laws of the State of Minnesota.

Print Name: PAUL D. HASLACH, PE, GAUSMAN & MOORE ASSOCIATES, INC.

Signature: ________________________________

Date: December 23 2019                             License # 24488

ELECTRICAL ENGINEER

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the Laws of the State of Minnesota.

Print Name: DAVE T. BLUME, PE, GAUSMAN & MOORE ASSOCIATES, INC.

Signature: ________________________________

Date: December 23, 2019                           License # 24671
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Hennepin County
North Regional Library Refurbishment

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INFORMATION AVAILABLE TO BIDDERS

1. Report of Subgrade Exploration
   A. The Owner has commissioned a geotechnical engineer to perform a geotechnical exploration and review of the existing soils. A copy of the report titled “Report of Geotechnical Exploration and Review”, prepared by American Engineering and Testing, dated July 3, 2018, is provided for Bidders information only and is not part of the Contract Documents.

2. Hazardous Material Reports
   A. Bulk Sample Results by Nova; B. Bulk Samples of Interior & Exterior caulking materials by IHSC.” (See attached)

END OF DOCUMENT
REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW

North Regional Library Refurbishment
Lowry Ave and Girard Ave
Minneapolis, Minnesota

Report No. 01-20036

Date:
July 3, 2018

Prepared for:
Hennepin County Facility Services
A2208 Government Center
300 South 6th Street
Minneapolis, MN 55487
July 3, 2018

Hennepin County Facility Services
A2208 Government Center
300 South 6th Street
Minneapolis, MN 55487

Attn: Lisa Bartels
Lisa.bartels@hennepin.us

RE: Geotechnical Exploration and Review
North Regional Library Refurbishment
Lowry Ave and Girard Ave
Minneapolis, Minnesota
AET Report No. 01-20036

Dear Ms. Bartels:

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the North Regional Library in Minneapolis, Minnesota. These services were performed according to our proposal dated April 25, 2018.

We are submitting this report as an electronic pdf copy. Please also contact me if you have any questions about the report.

Sincerely,

American Engineering Testing, Inc.

Thomas Evans, PE
Engineer I
Phone: (701) 690-9732
tevans@amengtest.com
SIGNATURE PAGE

Prepared for:
Hennepin County Facility Services
A2208 Government Center
300 South 6th Street
Minneapolis, MN 55487

Prepared by:
American Engineering Testing, Inc.
550 Cleveland Avenue North
St. Paul, Minnesota 55114
(651) 659-9001/www.amengtest.com

Attn: Lisa Bartels
Lisa.bartels@hennepin.us

Authored by:
Thomas Evans, PE
Engineer I

Reviewed by:
Jay Brekke, PE
Senior Engineer

I hereby certify that this report was prepared by
me or under my direct supervision and that I am
a duly Licensed Professional Engineer under
Minnesota Statute Section 326.02 to 326.15

Name: Thomas Evans
Date: 7/3/18
License #: 55092
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   Unified Soil Classification System
   Site Vicinity Map
   Boring Location Map
   Subsurface Boring Logs
   Sieve Analysis Test Results

APPENDIX B - Geotechnical Report Limitations and Guidelines for Use
1.0 INTRODUCTION
We understand the North Regional Library staff has documented is experiencing issues with the exterior pavements and sidewalks, possibly related to water infiltration. The library is located at the intersection of Lowry Avenue and Girard Avenue in Minneapolis, Minnesota. The project location is shown on the attached Site Vicinity Map included in Appendix.

American Engineering Testing, Inc. (AET) was hired to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of these services and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES
AET's services were performed according to our proposal dated April 25, 2018. The authorized scope consists of the following:
- Drilling 4 standard penetration test (SPT) borings to depths of 14.5 feet below grade;
- Performing routine soil laboratory testing; and,
- Conducting a geotechnical engineering analysis based on the gained data and preparing this report.
- Piezometers, hand auger borings, Wagner temperature/relative humidity, efflorescence mapping, and other services were proposed. However, these services were not authorized and were not performed. These additional services could be performed to assess the causes and effects of the water damage, especially within the library.

These services are intended for geotechnical purposes. The scope to explore for the presence of environmental contamination was limited to our field crew noting any visual or olfactory evidence in the soils samples.

3.0 PROJECT INFORMATION
We understand there have been several issues noted at the North Regional Library within the building and the sidewalks. According to the RFP, we understand the floor covering in the slab-on-grade portion of the library has bubbled, efflorescence has been observed on the eastern half of the south mechanical tunnel walls, and excessive heaving and settlement has been observed on site sidewalks.

Soil Exploration Company performed a geotechnical exploration prior to the construction of the library in 1970. Soil borings of the area were provided, but no recommendations were given in the
original report. The last renovation occurred in 2006 and 2007.

The above stated information represents our understanding of the project. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration Program

The subsurface exploration program conducted for the project consisted of 4 standard penetration test borings drilled on June 7 and 11, 2018. Three borings are located in the parking lot south of the library, and one boring is located north of the library in the boulevard. The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil classification, geologic description, and moisture condition. Relative density is also noted for the natural soils, which is based on the standard penetration resistance (N-value).

The approximate boring locations are shown on the Boring Location Map in Appendix A. AET staked the borings using GPS equipment at locations identified by the client. Our drill crew determined the ground surface elevations at the borings with an engineer’s level and the catch basin below the second story overhang of the library in the southern parking lot as the temporary benchmark (TBM). The elevation of the TBM was provided as 909.49 feet on a map from the client.

4.2 Laboratory Testing

The laboratory test program included visual/manual classification of the soil samples, moisture content, #200 sieve analysis, and gradation. The moisture content and #200 sieve analysis results are included on the attached boring logs opposite the samples upon which the tests were performed. The gradation test results are in the appendix following the boring logs.

5.0 SITE CONDITIONS

5.1 Surface Observations

At the time of drilling, there was a bituminous-paved parking lot south of the building and sidewalk and Lowry Avenue pavement north of the building. The ground surface elevations at our borings ranged from 904.4 feet to 910.5 feet. The parking lot is mostly flat.
5.2 Subsurface Soils/Geology

A brief description of the general subsurface conditions encountered at the boring locations follows. We wish to point out that the subsurface conditions at other times and locations at the site may differ from those found at our test boring locations.

At Borings B-1 and B-2 we found between 8¾ and 9 inches of bituminous underlain by approximately one foot of clayey sand and lean clay fill soils. Additionally, similar clayey sand and lean clay fill soils were encountered at the surface of Borings B-3 and B-4. Below the fill, alternating layers of till and alluvial soils were encountered and extended to the final drilling depths of 14.5 feet. The coarse alluvium consists of loose to very dense silty sand. The fine alluvium was only encountered in B-1 and consists of stiff to very stiff lean clay. The till soils consist of firm to very stiff clayey sand and lean clay.

5.3 Groundwater

The groundwater levels were measured in the borings upon completion of the borings. Groundwater was not observed in any of the 4 borings. However, we believe the site soils could cause a perched groundwater condition. Groundwater levels fluctuate due to varying seasonal and annual rainfall and snow melt amounts, local irrigation practices, as well as other factors.

6.0 RECOMMENDATIONS

6.1 Discussion

As mentioned earlier, no water was observed in the soil borings at the time of our exploration. We believe many of the site soils, including the lean clays and clayey sands, could act as aquitards that restrict the flow of groundwater through these layers and create perched groundwater conditions. If that is the case, the groundwater could sit in the soils above the clay and clayey sand layers and possibly start infiltrating into the nearby library. This is most evident in Boring B-1 where mostly coarse-grained silty sand soils are encountered above fine-grained lean clay soils. Rainwater would infiltrate into the silty sand layer and be perched on the lean clay layer below due to the low permeability nature of the lean clay soils. With nowhere else to go, the water could move laterally to the library.

Many of the on-site soils are at least moderately frost susceptible, including the silty sand, clayey sand, and lean clay soils. Ice lenses may form that could cause problematic frost heaving. This could contribute to the heaving and settlement of the sidewalks.

One method to limit the potential for frost heaving of sidewalks and slabs is to remove frost-
susceptible soils from below sidewalks, and provide drainage for replacement, non-frost susceptible soil. The silty and clayey site soils are considered frost susceptible. Typically, removal of frost susceptible soils to a depth of about 42 inches and replacing it with non-frost susceptible (NFS) sand will provide adequate protection from frost heaving. We recommend that imported sand be used as NFS backfill. We recommend that the sand should consist of sand or sand with silt having less than 5% (by weight) passing the No. 200 sieve. We recommend fill placed within the top 3 feet of the subgrade be compacted to a minimum of 98% of its standard Proctor test (ASTM: D698). Drain pipe should be placed at the bottom of the NFS sand to remove infiltrating groundwater. The drain pipes should outlet into the storm sewer system, if local ordinances allow, or be daylighted. The drain pipes should have a downward slope of at least 1% away from the sidewalks.

To reduce the potential for differential frost heave, a transition should be provided where logistics allow between the NFS sand and untreated areas paved. We recommend a minimum transition slope of at least four horizontal to one vertical (4H:1V) or flatter.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Potential Difficulties

7.1.1 Water in Excavation
Groundwater was not observed in our borings, but perched groundwater may be encountered in excavations during construction. To allow observation of the excavation bottom, and to reduce the potential for soil disturbance and facilitate filling operations, we recommend that all free-standing water within the excavations be removed prior to proceeding with construction.

7.1.2 Winter Construction
If construction occurs during the winter, it is necessary for the contractor to protect the base soils from freezing each day and each night before new fill is placed. Fill should not be placed over frozen soils, snow, or ice, nor should the use of frozen fill soils be permitted. The contractor must protect base soils from freezing before and after fill placement, and before, during, and after concrete placement.

7.2 Excavation Backsloping
If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, “Excavations” (can be found on www.osha.gov). Even with the required OSHA sloping, water seepage or surface runoff can potentially induce sideslope erosion or running which could require slope maintenance.
7.3 Observation and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Because the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observation by AET geotechnical personnel during construction to evaluate the effect of these potential changes.

Soil density testing should be performed on all fill placed at the site to document that our recommendations and the specifications for compaction have been satisfied. Where fill material type is important, laboratory sieve analyses should be performed to document that the actual fill meets the recommended gradation criteria. The building materials should also be tested in accordance with the project specifications and the building codes.

8.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either express or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix B entitled “Geotechnical Report Limitations and Guidelines for Use”.
Standard Sheets

Definitions Related to Pavement Construction
DEFINITIONS RELATING TO PAVEMENT CONSTRUCTION

Top of subgrade: Grade which contacts the bottom of the aggregate base layer.

Sand subbase: Uniform thickness sand layer placed as the top of subgrade which is intended to improve the frost and drainage characteristics of the pavement system by increasing drainage of excess water in the aggregate base and subbase, by reducing and “bridging” frost heaving, and by reducing spring thaw weakening effects.

Critical subgrade zone: The subgrade portion beneath and within three vertical feet of the top of subgrade. A sand subbase, if placed, would be considered the upper portion of the critical subgrade zone.

Suitable Grading Material: Mineral soil materials, typically from the project site, excluding the following: 1) soils which have an organic content exceeding 3%, 2) cohesive soils having a Liquid Limit exceeding 50%, 3) soils which include debris, cobbles, and/or boulders, and 4) soils which are considered acceptable from an environmental standpoint. The soil must also be capable of attaining the specified compaction level at its current water content or at a water content that can be reasonably scarified, blended, and moisture conditioned to a uniform water content in order to uniformly meet compaction requirements.

Granular Material: Soils meeting MnDOT Specification 3149.2B.1. This refers to granular soils which, of the portion passing the 1" sieve, contain less than 20% by weight passing the #200 sieve.

Select Granular Material: Soils meeting MnDOT Specification 3149.2B.2. This refers to granular soils which, of the portion passing the 1" sieve, contain less than 12% by weight passing the #200 sieve.

Select Granular Material (Super Sand): Soils meeting MnDOT Specification 3149.2B.3. This material is cleaner and coarser than Select Granular Material (see specification for specific requirements).

Compaction Subcut: Construction of a uniform thickness subcut below a designated grade to provide uniformity and compaction within the subcut zone. Replacement fill can be the materials subcut, although the reused soils should be blended to a uniform soil condition, moisture conditioned as needed to meet MnDOT Specification 2105.F; and re-compacted per the Specified Density Method defined in MnDOT Specification 2105.3F.1.

Test Roll: A means of evaluating the near-surface stability of subgrade soils (usually non-granular). Suitability is determined by the depth of rutting or deflection caused by passage of heavy rubber-tired construction equipment, such as a loaded dump truck, over the test area. Yielding of less than 1" is normally considered acceptable, although engineering judgment may be applied depending on the equipment used, soil conditions present, and/or depth below final grade.

Unstable Soils: Subgrade soils which do not pass a test roll. Unstable soils typically have water content exceeding the standard optimum water content defined in ASTM:D698 (Standard Proctor test).

Organic Soils: Soils which have sufficient organic content such that the soils engineering properties are negatively affected (typically more than 3% organic content). These soils are usually black to dark brown in color.
Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Site Vicinity Map
Boring Location Map
Subsurface Boring Logs
Sieve Analysis Test Results
Appendix A
Geotechnical Field Exploration and Testing
AET No. 01-20036

A.1 FIELD EXPLORATION
The subsurface conditions at the site were explored by drilling and sampling seven standard penetration test borings. The locations of the borings appear on Figure 1, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS
A.2.1 Split-Spoon Samples (SS) - Calibrated to N60 Values
Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586 with one primary modification. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value. Our method uses a modified hammer weight, which is determined by measuring the system energy using a Pile Driving Analyzer (PDA) and an instrumented rod.

In the past, standard penetration N-value tests were performed using a rope and cathead for the lift and drop system. The energy transferred to the split-spoon sampler was typically limited to about 60% of its potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

The most recent drill rigs incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N_{60} values. By using the PDA energy measurement equipment, we are able to determine actual energy generated by the drop hammer. With the various hammer systems available, we have found highly variable energies ranging from 55% to over 100%. Therefore, the intent of AET’s hammer calibrations is to vary the hammer weight such that hammer energies lie within about 60% to 65% of the theoretical energy of a 140-pound weight falling 30 inches. The current ASTM procedure acknowledges the wide variation in N-values, stating that N-values of 100% or more have been observed. Although we have not yet determined the statistical measurement uncertainty of our calibrated method to date, we can state that the accuracy deviation of the N-values using this method is significantly better than the standard ASTM Method.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)
Sample types described as “DS” or “SU” on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Sampling Limitations
Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of “topsoil” layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

A.3 CLASSIFICATION METHODS
Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.
A.4 WATER LEVEL MEASUREMENTS
The ground water level measurements are shown at the bottom of the boring logs. The following information appears under “Water Level Measurements” on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth at which free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 TEST STANDARD LIMITATIONS
Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.6 SAMPLE STORAGE
Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.
BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol  Definition
AR:  Sample of material obtained from cuttings blown out the top of the borehole during air rotary procedure.
B, H, N:  Size of flush-joint casing
CAS:  Pipe casing, number indicates nominal diameter in inches
COT:  Clean-out tube
DC:  Drive casing; number indicates diameter in inches
DM:  Drilling mud or bentonite slurry
DR:  Driller (initials)
DS:  Disturbed sample from auger flights
DP:  Direct push drilling; a 2.125 inch OD outer casing with an inner 1½ inch ID plastic tube is driven continuously into the ground.
FA:  Flight auger; number indicates outside diameter in inches
HA:  Hand auger; number indicates outside diameter
HSA:  Hollow stem auger; number indicates inside diameter in inches
LG:  Field logger (initials)
MC:  Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):  Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:  NQ wireline core barrel
PQ:  PQ wireline core barrel
RDA:  Rotary drilling with compressed air and roller or drag bit.
RDF:  Rotary drilling with drilling fluid and roller or drag bit
REC:  In split-spoon (see notes), direct push and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
SS:  Standard split-spoon sampler (steel; 1.5” is inside diameter; 2” outside diameter); unless indicated otherwise
SU:  Spin-up sample from hollow stem auger
TW:  Thin-walled tube; number indicates inside diameter in inches
WASH:  Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after “falling” through drilling fluid
WH:  Sampler advanced by static weight of drill rod and hammer
WR:  Sampler advanced by static weight of drill rod
94mm:  94 millimeter wireline core barrel
▼:  Water level directly measured in boring
▼:  Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol  Definition
CONS:  One-dimensional consolidation test
DEN:  Dry density, pcf
DST:  Direct shear test
E:  Pressuremeter Modulus, tsf
HYD:  Hydrometer analysis
LL:  Liquid Limit, %
LP:  Pressuremeter Limit Pressure, tsf
OC:  Organic Content, %
PERM:  Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:  Plastic Limit, %
q_u:  Pocket Penetrometer strength, tsf (approximate)
q_c:  Static cone bearing pressure, tsf
q_o:  Unconfined compressive strength, psf
R:  Electrical Resistivity, ohm-cms
RQD:  Rock Quality Designation of Rock Core, in percent (aggregate length of core pieces 4” or more in length as a percent of total core run)
SA:  Sieve analysis
TRX:  Triaxial compression test
VSR:  Vane shear strength, remolded (field), psf
VSU:  Vane shear strength, undisturbed (field), psf
WC:  Water content, as percent of dry weight
%-200:  Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES
(Calibrated Hammer Weight)

The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N_{60} values) and counting the number of blows applied in each of three 6” increments of penetration. If the sampler is driven less than 18” (usually in highly resistant material), permitted in ASTM D1586, the blows for each complete 6” increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1’ below the slash.

The length of sample recovered, as shown on the “REC” column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6” set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18”).
UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests A

<table>
<thead>
<tr>
<th>Soil Classification</th>
<th>Group Symbol</th>
<th>Group Name</th>
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<td>Coarse-Grained</td>
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<td>Primarily organic</td>
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<td>in odor</td>
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<td>PT</td>
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<tr>
<td>Peat</td>
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**ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION**

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<thead>
<tr>
<th>Term</th>
<th>Grain Size</th>
<th>Gravel Percentages</th>
<th>Consistency of Plastic Soils</th>
<th>Relative Density of Non-Plastic Soils</th>
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<tr>
<td></td>
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<td></td>
<td>Term</td>
<td>N-Value, BPF</td>
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<tr>
<td>Boulders</td>
<td>Over 12&quot;</td>
<td>A Little Gravel 3% - 14%</td>
<td>Very Soft</td>
<td>less than 2</td>
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<td>Cobbles</td>
<td>3&quot; to 12&quot;</td>
<td>With Gravel 15% - 29%</td>
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<td>#200 to #4 sieve</td>
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<td>Pass #200 sieve</td>
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<td>Very Stiff</td>
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<td>Hard</td>
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**Moisture/Frost Condition**

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<tr>
<td>D</td>
<td>(Dry)</td>
<td>Absence of moisture, dusty, dry to touch.</td>
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<tr>
<td>M</td>
<td>(Moist)</td>
<td>Damp, although free water not visible. Soil may still have a high water content (over “optimum”).</td>
</tr>
<tr>
<td>W</td>
<td>(Wet)</td>
<td>Waterbearing usually relates to sands and sand with silt.</td>
</tr>
<tr>
<td>F</td>
<td>(Frozen)</td>
<td>Soil frozen</td>
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**Layering Notes**

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<tr>
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</tr>
<tr>
<td>W</td>
<td>(Wet)</td>
<td>Waterbearing usually relates to sands and sand with silt.</td>
</tr>
<tr>
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<td>(Frozen)</td>
<td>Soil frozen</td>
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**Peat Description**

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<tr>
<th>Term</th>
<th>Moisture Condition</th>
<th>Soil Properties</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>M</td>
<td>(Moist)</td>
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<td>W</td>
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</tr>
<tr>
<td>F</td>
<td>(Frozen)</td>
<td>Soil frozen</td>
</tr>
</tbody>
</table>

**Organic Description (if no lab tests)**

Soils are described as organic, if soil is not peat and is judged to have sufficient organic fines content to influence the Liquid Limit properties. Slightly organic used for borderline cases.

**Root Inclusions**

With roots: Judged to have sufficient quantity of organic content to influence the soil properties.

**Trace roots:** Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.
# Subsurface Boring Log

**Log of Boring No.: B-1 (p. 1 of 1)**

**AET No.: 01-20036**  
**Project:** North Regional Library; Lowry Avenue; Minneapolis, MN

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Surface Elevation</th>
<th>Material Description</th>
<th>Geology</th>
<th>Sample Type</th>
<th>REC IN.</th>
<th>Field &amp; Laboratory Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.75&quot;</td>
<td>910.5</td>
<td>8.75&quot; Bituminous pavement</td>
<td>FILL</td>
<td>SU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>CLAYEY SAND, a little gravel, reddish brown, very stiff (SC) (possible fill)</td>
<td>TILL/FILL</td>
<td>M</td>
<td>SS</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>SILTY SAND, a little gravel, fine to medium grained, reddish brown, moist, medium dense to loose (SM)</td>
<td>COARSE ALLUVIUM</td>
<td>M</td>
<td>SS</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>SILTY SAND, a little gravel, fine to medium grained, brown, moist, medium dense, lenses of clayey sand (SM)</td>
<td></td>
<td>M</td>
<td>SS</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>SS</td>
<td>24</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>SS</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>SS</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>SS</td>
<td>43</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>END OF BORING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Depth:**
- 0-12½’

**Drilling Method:**
- 3.25" HSA

**Water Level Measurements:**
- 6/7/18
- 9:40
- Sampled Depth: 14.5
- Casing Depth: 12.5
- Cave-in Depth: 14.5
- Drilling Fluid Level: None
- Water Level: None

**Boring Completed:** 6/7/18

**DR:** DS  
**LG:** SB  
**Rig:** 1C

---

**Note:** Refer to the attached sheets for an explanation of terminology on this log.
## Subsurface Boring Log

### AET No: 01-20036

**Project:** North Regional Library; Lowry Avenue; Minneapolis, MN

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Surface Elevation</th>
<th>Material Description</th>
<th>GEOLOGY</th>
<th>N</th>
<th>MC</th>
<th>SAMPLE Type</th>
<th>REC IN</th>
<th>FIELD &amp; LABORATORY TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>9&quot; Bituminous pavement</td>
<td>FILL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>LEAN CLAY WITH SAND, a little gravel, reddish brown, firm (CL) (possible fill)</td>
<td>FINE \ ALLUVIUM/ \ FILL</td>
<td>7</td>
<td>M</td>
<td>SS</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>SANDY LEAN CLAY a little gravel, reddish brown, moist, stiff to very stiff (CL)</td>
<td>TILL</td>
<td>11</td>
<td>M</td>
<td>SS</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>M</td>
<td>SS</td>
<td>15</td>
<td>18</td>
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<tr>
<td>4</td>
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<td>M</td>
<td>SS</td>
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<td>SS</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>COARSE \ ALLUVIUM</td>
<td>60</td>
<td>M</td>
<td>SS</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>GRAVELLY SILTY SAND, fine to medium grained, brown, moist, medium dense (SM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>SILTY SAND, a little gravel, fine grained, reddish brown, moist, dense to very dense (SM) (possible cobble at 11.5')</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>END OF BORING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Depth:** 0-12½’

**Drilling Method:** 3.25" HSA

**Water Level Measurements:**

- **Date:** 6/7/18
- **Time:** 8:20
- **Sampled Depth:** 14.5
- **Casing Depth:** 12.5
- **Cave-In Depth:** 14.5
- **Drilling Fluid Level:** None
- **Water Level:** None

**Note:** Refer to the attached sheets for an explanation of terminology on this log.

**Drilling Completed:** 6/7/18

**DR:** DS  **LG:** SB  **Rig:** 1C

**03/2011**

**01-DHR-060**
## Subsurface Boring Log

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Surface Elevation</th>
<th>Material Description</th>
<th>GEOLOGY</th>
<th>N</th>
<th>MC</th>
<th>Sample Type</th>
<th>REC.</th>
<th>Field &amp; Laboratory Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>910.5</td>
<td>FILL, mixture of sandy lean clay and wood chips, trace roots, reddish brown</td>
<td>FILL</td>
<td>3</td>
<td>M</td>
<td>SS</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>LEAN CLAY, a little sand, a little gravel, reddish brown, very stiff (CL)</td>
<td>TILL</td>
<td>25</td>
<td>M</td>
<td>SS</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>SILTY SAND, a little gravel, reddish brown, dense to medium dense (SM)</td>
<td>COARSE ALLUVIUM</td>
<td>31</td>
<td>M</td>
<td>SS</td>
<td>18</td>
<td></td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Depth: Water Level Measurements**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Method</th>
<th>Date</th>
<th>Time</th>
<th>Sampled Depth</th>
<th>Casing Depth</th>
<th>Cave-in Depth</th>
<th>Drilling Fluid Level</th>
<th>Water Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12½'</td>
<td>3.25&quot; HSA</td>
<td>6/7/18</td>
<td>7:40</td>
<td>14.5</td>
<td>12.5</td>
<td>14.5</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6/7/18</td>
<td>7:50</td>
<td>14.5</td>
<td>12.5</td>
<td>14.5</td>
<td>None</td>
<td></td>
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</table>

**Note:** Refer to the attached sheets for an explanation of terminology on this log.

**Boring Completed:** 6/7/18

**DR:** DS  **LG:** SB  **Rig:** 1C
**SUBSURFACE BORING LOG**

<table>
<thead>
<tr>
<th>DEPTH IN FEET</th>
<th>Surface Elevation</th>
<th>MATERIAL DESCRIPTION</th>
<th>GEOLOGY</th>
<th>N</th>
<th>MC</th>
<th>SAMPLE TYPE</th>
<th>REC IN.</th>
<th>FIELD &amp; LABORATORY TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>FILL, mixture of clayey sand, lean clay, trace roots, black and brown</td>
<td>FILL</td>
<td>6</td>
<td>M</td>
<td>SS</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>SANDY LEAN CLAY, a little gravel, brown, firm to very stiff (CL)</td>
<td>TILL</td>
<td>6</td>
<td>M</td>
<td>SS</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>M</td>
<td>SS</td>
<td>21</td>
<td>16</td>
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<tr>
<td>4</td>
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<td>16</td>
<td>M</td>
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<td></td>
<td></td>
<td>25</td>
<td>M</td>
<td>SS</td>
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<td></td>
<td></td>
<td>25</td>
<td>M</td>
<td>SS</td>
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<td></td>
<td></td>
<td>25</td>
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<td></td>
<td></td>
<td>25</td>
<td>M</td>
<td>SS</td>
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<td>12</td>
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<td></td>
<td></td>
<td>25</td>
<td>M</td>
<td>SS</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>SILTY SAND, a little gravel, fine to medium grained, reddish brown, moist, very dense (SM)</td>
<td>COARSE ALLUVIUM</td>
<td>84</td>
<td>M</td>
<td>SS</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>END OF BORING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DEPTH:**
- 0-12¾′

**DRILLING METHOD:** 3.25″ HSA

**WATER LEVEL MEASUREMENTS**
- 0-12¾′: 3.25″ HSA
  - DATE: 6/11/18
  - TIME: 8:53
  - SAMPLED DEPTH: 14.5
  - CASING DEPTH: 12.5
  - CAVE-IN DEPTH: 12.5
  - DRILLING FLUID LEVEL: None
  - WATER LEVEL: None

**DRILLING METHOD:**
- NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

**BORING COMPLETED:** 6/11/18

**DR: DS  LG: SG  Rig: 1C**
Appendix B

Geotechnical Report Limitations and Guidelines for Use
B.1 REFERENCE
This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by ASFE\(^1\), of which, we are a member firm.

B.2 RISK MANAGEMENT INFORMATION
B.2.1 Geotechnical Services are Performed for Specific Purposes, Persons, and Projects
Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the Client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. And no one, not even you, should apply the report for any purpose or project except the one originally contemplated.

B.2.2 Read the Full Report
Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

B.2.3 A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors
Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typically factors include: Clients goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it’s changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

B.2.4 Subsurface Conditions Can Change
A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

---

\(^1\) ASFE, 8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733; www.asfe.org
Appendix B
Geotechnical Report Limitations and Guidelines for Use
Report No. 01-20036

B.2.5 Most Geotechnical Findings Are Professional Opinions
Site exploration identified subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

B.2.6 A Report’s Recommendations Are Not Final
Do not over rely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report’s recommendations if that engineer does not perform construction observation.

B.2.7 A Geotechnical Engineering Report Is Subject to Misinterpretation
Other design team members’ misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team’s plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

B.2.8 Do Not Redraw the Engineer’s Logs
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognizes that separating logs from the report can elevate risk.

B.2.9 Give Contractors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report’s accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

B.2.10 Read Responsibility Provisions Closely
Some owners, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled “limitations” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.11 Geoenvironmental Concerns Are Not Covered
The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.
October 7, 2008

Michael Tupy
Hennepin County Property Services
A-2208 300 South 6th Street
Minneapolis, MN 55487

RE: BULK SAMPLE RESULTS
HENNEPIN COUNTY PROPERTY SERVICES
NORTHWEST REGIONAL LIBRARY
NOVA PROJECT NO: H08-1151

Dear Mr. Tupy:

Please find enclosed the analysis of the bulk samples of building materials that Nova collected on July 28, 2008. These samples were analyzed for asbestos utilizing the Environmental Protection Agency (EPA) recommended polarized-light microscopy technique described in "Method for the Determination of Asbestos in Bulk Building Materials", EPA/600/R-93/116, July 1993 and Federal regulations 40 CFR Chapter I (7/1/92 edition), Part 763, Subpart F, Appendix A, pages 546-551. The results of the analysis are listed on the accompanying table.

This report relates only to the items tested. Analysis for asbestos content is determined by visual estimation expressed as an area percent, and distinguishes the following types of asbestos: chrysotile (serpentine), amosite (cumminstonite-grunerite), crocidolite (riebeckite), anthophyllite, tremolite, and actinolite. If the sample is not homogeneous, each component is analyzed and reported separately by layer.

According to the National Emission Standards for Hazardous Air Pollutants; Asbestos NESHAP Revision Final Rule in the Federal Register, Vol. 55, No. 224 (11/20/90 edition), any friable material found to be asbestos-containing at a quantity of less than 10 percent by visual estimation may be verified by the point count method of quantification. The building owner may either assume the asbestos quantity to be greater than one percent and treat the material as ACM, or may require a point count. However, if a result obtained by point counting differs from the visual estimation result, the point count result must be used.

Nova assumes no responsibility for customer supplied data such as sample type, location, or area sampled. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. government. This report shall not be reproduced except in full, without the written approval of the laboratory. Samples are retained at our laboratory for one (1) year and then disposed of unless we are instructed otherwise. If you should have any questions or if we can be of further service, please feel free to contact us at your convenience.

Sincerely,

NOVA CONSULTING GROUP, INC.

Lance Robinette
Project Manager

LSR:law

H08-1151R 001-LSR

an equal opportunity employer
Hazecline Gates Suite 400 1167 Hazeltine Boulevard Minneapolis, MN 55318-1041
(952) 448-9393 FAX (952) 448-9572
## Table 1: Material Identification Inventory

**Project Number:** H08-1151  
**Client Name:** Michael Tupy  
**Client Number:** HENNE001  
**Building Name:** Minneapolis North Regional Library  
**Login Number:** Unassigned  
**Building Address:** 1315 Lowry Avenue North, Minneapolis, MN 55411  
**Survey Date:** 7/28/08

<table>
<thead>
<tr>
<th>Area:</th>
<th>North Regional Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Room Number</td>
</tr>
<tr>
<td>1st Floor Main Area</td>
<td>313</td>
</tr>
<tr>
<td>1st Floor Main Area</td>
<td>313</td>
</tr>
<tr>
<td>2nd Floor Janitors Closet</td>
<td>246</td>
</tr>
<tr>
<td>2nd Floor Large Storage Room</td>
<td>101</td>
</tr>
<tr>
<td>2nd Floor Main Area</td>
<td>313</td>
</tr>
<tr>
<td>2nd Floor Main Area</td>
<td>313</td>
</tr>
<tr>
<td>2nd Floor Meeting Room A</td>
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</tr>
<tr>
<td>2nd Floor Meeting Room B</td>
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ND = None Detected  
NSMP = No Suspect Materials Present  
NT = Not Tested  
NS = Not Suspect  
PGE = Presumed TR = Trace (<1%)
# Table 1: Material Identification Inventory

**Nova Consulting Group, Inc.**  
**1107 Hazeltine Boulevard, Suite #400**  
**Chaska, MN 55318**

**Project Number:** H08-1151  
**Client Number:** HENNE001  
**Login Number:** Unassigned  
**Building Number:** Minneapolis North Regional Library  
**Client Name:** Michael Tupy  
**Building Name:** Minneapolis North Regional Library  
**Building Address:** 1315 Lowry Avenue North, Minneapolis, MN 55411  
**Survey Date:** 7/28/08

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>2nd Floor North Stair Well</td>
<td>101 SOC</td>
<td>Spray-On Sprayed Ceiling</td>
<td>S</td>
<td>ND</td>
<td>2000 SF</td>
<td></td>
<td>0 NA</td>
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<tr>
<td>2nd Floor Small Storage Room</td>
<td>310 WFT</td>
<td>12x12 Floor Tile &amp; Mastic White Floor Tile</td>
<td>M</td>
<td>ND</td>
<td>100 SF</td>
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<td>0 NA</td>
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<tr>
<td>2nd Floor South Stair Well</td>
<td>101 SOC</td>
<td>Spray-On Sprayed Ceiling</td>
<td>S</td>
<td>ND</td>
<td>2000 SF</td>
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<td>0 NA</td>
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<td>ND</td>
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<td>ND</td>
<td>2 EA</td>
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<td>0 NA</td>
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**ND** = None Detected  
**NSMP** = No Suspect Materials Present  
**NT** = Not Tested  
**NS** = Not Suspect  
**PRE** = Presumed  
**TR** = Trace (<1%)
Table 2: Bulk Sample Analysis / Chain of Custody

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<tr>
<th>Project Number:</th>
<th>H08-1151</th>
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<tbody>
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<td>Client Number:</td>
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<td>Building Name:</td>
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<td>1315 Lowry Avenue North, Minneapolis, MN 55411</td>
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<td>Survey Date:</td>
<td>7/28/08</td>
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<tr>
<td>Project Manager:</td>
<td>Lance Robinette</td>
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<td>Quality Control Blank:</td>
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<td>Received By:</td>
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<tr>
<td>Relinquished By:</td>
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<td>Date/Time:</td>
<td>8/28/2008</td>
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<td>Date/Time:</td>
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<tr>
<th>Container Type:</th>
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<tr>
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<td>25</td>
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<tr>
<td>Reporting Limit:</td>
<td>1% Asbestos</td>
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</table>

ND = None Detected  NT = Not Tested  TRACE = <1%
**Table 2: Bulk Sample Analysis / Chain of Custody**

Nova Consulting Group, Inc.
1107 Hazeltine Boulevard, Suite #400
Chaska, MN 55318

<table>
<thead>
<tr>
<th>Project Number:</th>
<th>H08-1151</th>
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<td>Client Number:</td>
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<td>Minneapolis North Regional Library</td>
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<tr>
<td>Building Number:</td>
<td>1315 Lowry Avenue North, Minneapolis, MN 55411</td>
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| Survey Date: | 7/28/08 |

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<tr>
<th>Mit#-Sub-Ltr</th>
<th>Sample Pos.</th>
<th>Area Location / Room#</th>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Friability</th>
<th>Asbestos Fibers</th>
<th>Non-Asbestos</th>
<th>Comments/ Nonfibrous Material</th>
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<tbody>
<tr>
<td>101-SOC-A</td>
<td>101-SOC-A</td>
<td>North Regional Library 2nd Floor / South Stair Well</td>
<td>Spray-On</td>
<td>Spray On Ceiling</td>
<td>ND</td>
<td>80% Non-fibrous</td>
<td>20% Mica</td>
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<tr>
<td>101-SOC-B</td>
<td>101-SOC-B</td>
<td>North Regional Library 2nd Floor / Large Storage Room</td>
<td>Spray-On</td>
<td>Spray On Ceiling</td>
<td>ND</td>
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<td>20% Mica</td>
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<tr>
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<td>101-SOC-C</td>
<td>North Regional Library 2nd Floor / Large Storage Room</td>
<td>Spray-On</td>
<td>Spray On Ceiling</td>
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<td>80% Non-fibrous</td>
<td>20% Mica</td>
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<tr>
<td>101-SOC-D</td>
<td>101-SOC-D</td>
<td>North Regional Library 2nd Floor / Meeting Room</td>
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<td>Spray On Ceiling</td>
<td>ND</td>
<td>80% Non-fibrous</td>
<td>20% Mica</td>
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<td>Spray On Ceiling</td>
<td>ND</td>
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<td>20% Mica</td>
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<tr>
<td>246-HF-A</td>
<td>246-HF-A</td>
<td>North Regional Library 2nd Floor / Janitor's Closet</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
<td>ND</td>
<td>90% Cellulose</td>
<td>Wrap</td>
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</tr>
<tr>
<td>246-HF-B</td>
<td>246-HF-B</td>
<td>North Regional Library 2nd Floor / Janitors Closet</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
<td>ND</td>
<td>35% Min. Wool</td>
<td>65% Non-fibrous</td>
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<tr>
<td>246-HF-C</td>
<td>246-HF-C</td>
<td>North Regional Library Garage / Janitors Area</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
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<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
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<td>90% Cellulose</td>
<td>Wrap</td>
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</tbody>
</table>

ND = None Detected  NT = Not Tested  TRACE = <1%
### Table 2: Bulk Sample Analysis / Chain of Custody

**Nova Consulting Group, Inc.**  
1107 Hazeltine Boulevard, Suite #400  
Chaska, MN 55318

**Project Number:** H08-1151  
**Client Number:** HENNE001  
**Login Number:** Unassigned  
**Building:** Minneapolis North Regional Library  
**Building Name:** Minneapolis North Regional Library  
**Building Address:** 1315 Lowry Avenue North, Minneapolis, MN 55411

<table>
<thead>
<tr>
<th>MtL#-Sub-Ltr Sample Pos.</th>
<th>Area Location / Room#</th>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Friability</th>
<th>Asbestos Fibers</th>
<th>Non-Asbestos</th>
<th>Comments/Non-fibrous Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>310-BFT-A</td>
<td>North Regional Library 2nd Floor / South Stair Well</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>Beige Floor Tile</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td>100% Non-fibrous</td>
<td></td>
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<tr>
<td>310-BFT-B</td>
<td>North Regional Library 2nd Floor / South Stair Well</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>Beige Floor Tile</td>
<td>ND</td>
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<td>ND</td>
<td>100% Non-fibrous</td>
<td></td>
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<tr>
<td>310-BFT-C</td>
<td>North Regional Library 2nd Floor / South Stair Well</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>Beige Floor Tile</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td>100% Non-fibrous</td>
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</tr>
<tr>
<td>310-BFT-C</td>
<td>North Regional Library 2nd Floor / South Stair Well</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>Beige Floor Tile</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td>100% Non-fibrous</td>
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</tr>
<tr>
<td>310-WFT-A</td>
<td>North Regional Library 2nd Floor / Small Storage Room</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>White Floor Tile</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td>100% Non-fibrous</td>
<td></td>
</tr>
<tr>
<td>310-WFT-A</td>
<td>North Regional Library 2nd Floor / Small Storage Room</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>White Floor Tile</td>
<td>ND</td>
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<tr>
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<td>12x12 Floor Tile &amp; Mastic</td>
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<td>ND</td>
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<td>ND</td>
<td>Floor</td>
<td>100% Non-fibrous</td>
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<tr>
<td>310-WFT-B</td>
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<td>Mastic/Tan</td>
<td>100% Non-fibrous</td>
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<tr>
<td>310-WFT-C</td>
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<tr>
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<td>Mastic/Tan</td>
<td>100% Non-fibrous</td>
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</table>

C:\Documents and Settings\cancerobincite\Desktop\Hennepin  
ND = None Detected  
NT = Not Tested  
TRACE = <1%

Page 3 of 5
Table 2: Bulk Sample Analysis / Chain of Custody

Nova Consulting Group, Inc.
1107 Hazeltine Boulevard, Suite #400
Chaska, MN 55318

Project Number: H08-1151  
Client Number: HENNE001  
Login Number: Unassigned  
Building: Minneapolis North Regional Library

Building Name: Minneapolis North Regional Library  
Building Address: 1315 Lowry Avenue North, Minneapolis, MN 55411

Survey Date: 7/28/08

<table>
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<tr>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Friability</th>
<th>Asbestos Fibers</th>
<th>Non-Asbestos</th>
<th>Comments/Nonfibrous Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>313-BGSF-A North Regional Library 2nd Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Beige Sheet Floor</td>
<td>ND</td>
<td>10% Cellulose</td>
<td>Flooring 85% Non-fibrous</td>
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<tr>
<td>313-BGSF-A North Regional Library 2nd Floor / Main Area</td>
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<td>Flooring 85% Non-fibrous</td>
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<tr>
<td>313-BGSF-B North Regional Library 2nd Floor / Main Area</td>
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<td>Beige Sheet Floor</td>
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<td>15% Cellulose</td>
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<td>Flooring 85% Non-fibrous</td>
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<td>Flooring 85% Non-fibrous</td>
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<td>313-BLSF-A North Regional Library 1st Floor / Main Area</td>
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<td>Blue Sheet Floor</td>
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<td>313-BLSF-B North Regional Library 1st Floor / Main Area</td>
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<td>313-BLSF-B North Regional Library 1st Floor / Main Area</td>
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<td>Blue Sheet Floor</td>
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<td>Flooring 85% Non-fibrous</td>
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<td>Blue Sheet Floor</td>
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<tr>
<td>313-BLSF-C North Regional Library 1st Floor / Main Area</td>
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<td>Blue Sheet Floor</td>
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<td>15% Cellulose</td>
<td>Flooring 85% Non-fibrous</td>
<td></td>
</tr>
<tr>
<td>313-RSF-A North Regional Library 2nd Floor / Main Area</td>
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<td>Red Sheet Floor</td>
<td>ND</td>
<td>20% Mica</td>
<td>Flooring 80% Non-fibrous</td>
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</table>

ND = None Detected  NT = Not Tested  TRACE = <1%
<table>
<thead>
<tr>
<th>Mtl#-Sub-Ltr</th>
<th>Area</th>
<th>Location / Room#</th>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Friability</th>
<th>Asbestos Fibers</th>
<th>Non-Asbestos</th>
<th>Comments/Nonfibrous Material</th>
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<td>Sheet Floor &amp; Mastic</td>
<td>Red Sheet Floor</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td>15% Cellulose</td>
<td>Backing 100% Non-fibrous</td>
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<tr>
<td>313-RSF-B</td>
<td>North Regional Library</td>
<td>2nd Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Red Sheet Floor</td>
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<td></td>
<td>ND</td>
<td>15% Cellulose</td>
<td>Flooring 85% Non-fibrous</td>
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7. Hard Fittings
Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

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<th>Sample</th>
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<th>Appearance</th>
<th>% Fibrous</th>
<th>% Non-Fibrous</th>
<th>Asbestos % Type</th>
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<td>Layers: 2</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>310-WFT-B FLOOR TILE</td>
<td>North Regional Library 2nd Floor/ Small Storage Ro</td>
<td>Cream</td>
<td>100%</td>
<td>Non-fibrous</td>
<td>Non-Detected</td>
</tr>
<tr>
<td>350803941-0002</td>
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<td>Layers: 2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>310-WFT-B MASTIC</td>
<td>North Regional Library 2nd Floor/ Small Storage Ro</td>
<td>Tan</td>
<td>100%</td>
<td>Non-fibrous</td>
<td>Non-Detected</td>
</tr>
<tr>
<td>350803941-0002A</td>
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<td>Non-Fibrous</td>
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<td></td>
</tr>
<tr>
<td>310-WFT-C FLOOR TILE</td>
<td>North Regional Library 2nd Floor/ Small Storage Ro</td>
<td>Cream</td>
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<td>Non-fibrous</td>
<td>Non-Detected</td>
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<td>350803941-0003</td>
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<tr>
<td>310-WFT-C MASTIC</td>
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<td>100%</td>
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<tr>
<td>313-BGSF-A FLOORING</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Beige</td>
<td>15%</td>
<td>Cellulose</td>
<td>Non-Detected</td>
</tr>
<tr>
<td>350803941-0004</td>
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<td>Non-Fibrous</td>
<td></td>
<td></td>
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<td></td>
<td>Layers: 2</td>
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</tbody>
</table>

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. The limit of detection, as stated in the method, is 1%. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL’s liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government.

NVLAP Lab Code 200919-0

PLM-1
Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>Non-Asbestos</th>
<th>Asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>313-BGSF-A</td>
<td>North Regional Library 2nd Floor/Main Area</td>
<td>Tan Fibrous</td>
<td>100% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>BACKING</td>
<td></td>
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<tr>
<td></td>
<td>350803941-0000A</td>
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</tr>
<tr>
<td>313-BGSF-B</td>
<td>North Regional Library 2nd Floor/Main Area</td>
<td>Beige Non-Fibrous</td>
<td>15% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>FLOORING</td>
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<tr>
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<td>350803941-0005</td>
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</tr>
<tr>
<td>313-BGSF-B</td>
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<td>Tan Fibrous</td>
<td>100% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>BACKING</td>
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<tr>
<td>313-BGSF-C</td>
<td>1st Floor Main area</td>
<td>Blue Non-Fibrous</td>
<td>15% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>FLOORING</td>
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<td>350803941-0006</td>
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</tr>
<tr>
<td>313-BGSF-C</td>
<td>1st Floor Main area</td>
<td>Tan Fibrous</td>
<td>100% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>BACKING</td>
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<td>350803941-0006A</td>
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</tr>
<tr>
<td>313-BSLF-A</td>
<td>North Regional Library 2nd Floor/Main Area</td>
<td>Red Non-Fibrous</td>
<td>15% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>FLOORING</td>
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<td>350803941-0007</td>
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</tr>
<tr>
<td>313-BSLF-A</td>
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<td>Tan Fibrous</td>
<td>100% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>BACKING</td>
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Analyst(s)
Erin Ortman (92)

Rachel Travis, Laboratory Manager or other approved signatory

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. The limit of detection as stated in the method is 1%. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government.

NVLAP Lab Code 200019-0
Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>Non-Asbestos</th>
<th>Asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>313-BLSF-B</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Red</td>
<td>15% Cellulose</td>
<td>85% Non-Fibrous (other)</td>
</tr>
<tr>
<td>BACKING</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>313-BLSF-C</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Tan</td>
<td>100% Cellulose</td>
<td></td>
</tr>
<tr>
<td>BACKING</td>
<td></td>
<td>Fibrous</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>313-BLSF-C</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Red</td>
<td>15% Cellulose</td>
<td>85% Non-Fibrous (other)</td>
</tr>
<tr>
<td>BACKING</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>313 RSF-A</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Gray</td>
<td>20% Mica</td>
<td></td>
</tr>
<tr>
<td>FLOORING</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Homogeneous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>313 RSF-A</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Tan</td>
<td>100% Cellulose</td>
<td></td>
</tr>
<tr>
<td>BACKING</td>
<td></td>
<td>Fibrous</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>313 RSF-B</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Red</td>
<td>15% Cellulose</td>
<td>85% Non-Fibrous (other)</td>
</tr>
<tr>
<td>FLOORING</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
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<td></td>
</tr>
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</table>

Analysis(s)

Erin Orthum (48)

Rachel Travis, Laboratory Manager or other approved signatory

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NVLAP Lab Code 200019-0

PLM-1
**Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>Non-Asbestos</th>
<th>Asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>313 RSF-B</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Tan</td>
<td>% Fibrous: 100% Cellulose</td>
<td>None Detected</td>
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<tr>
<td>BACKING</td>
<td></td>
<td></td>
<td>% Non-Fibrous: Cellulose</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>313 RSF-C</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Red</td>
<td>% Fibrous: 15% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>FLOORING</td>
<td></td>
<td></td>
<td>% Non-Fibrous: 85% Non-fibrous</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>313 RSF-C</td>
<td>North Regional Library 2nd Floor/ Main Area</td>
<td>Tan</td>
<td>% Fibrous: 100% Cellulose</td>
<td>None Detected</td>
</tr>
<tr>
<td>BACKING</td>
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<td></td>
<td>% Non-Fibrous: Cellulose</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-SOC-A</td>
<td>North Regional Library 2nd Floor/ South Stair Well</td>
<td>Gray</td>
<td>% Fibrous: 20% Mica</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>% Non-Fibrous: 80% Non-fibrous</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-SOC-B</td>
<td>North Regional Library 2nd Floor/ Large Storage Ro</td>
<td>Gray</td>
<td>% Fibrous: 20% Mica</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>% Non-Fibrous: 80% Non-fibrous</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-SOC-C</td>
<td>North Regional Library 2nd Floor/ Large Storage Ro</td>
<td>Gray</td>
<td>% Fibrous: 20% Mica</td>
<td>None Detected</td>
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<td></td>
<td></td>
<td></td>
<td>% Non-Fibrous: 80% Non-fibrous</td>
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<td></td>
<td></td>
<td>Layers: 2</td>
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<td>101-SOC-D</td>
<td>North Regional Library 2nd Floor/ Meeting Room</td>
<td>Gray</td>
<td>% Fibrous: 20% Mica</td>
<td>None Detected</td>
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<td>% Non-Fibrous: 80% Non-fibrous</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Layers: 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Analyser(s):
Erin Ortlun (4P)*

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NVLAP Lab Code 200519-0
Attn: Joe Towner  
NOVA Consulting Group, Inc.  
1107 Hazeltine Blvd. Suite 400  
Chaska, MN 55318  

Fax: (952) 448-9572  
Phone: (952) 448-9393  
Project: H08-1151

Customer ID: NOVA52  
Customer PO:  
Received: 07/29/08 11:50 AM  
EMSL Order: 35083941  
EMSL Req:  
Analysis Date: 7/30/2008  
Report Date: 7/31/2008

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>Non-Asbestos</th>
<th>Asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-SOC-E</td>
<td>North Regional Library 2nd Floor/ Meeting Room</td>
<td>Gray Non-Fibrous Homogeneous</td>
<td>20% Mica</td>
<td>None Detected</td>
</tr>
<tr>
<td>350803941-0017</td>
<td></td>
<td></td>
<td>80% Non-fibrous (other)</td>
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<tr>
<td>101-SOC-F</td>
<td>North Regional Library 2nd Floor/ North Stair</td>
<td>Gray Non-Fibrous Homogeneous</td>
<td>20% Mica</td>
<td>None Detected</td>
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<tr>
<td>350803941-0018</td>
<td></td>
<td></td>
<td>80% Non-fibrous (other)</td>
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</tr>
<tr>
<td>101-SOC-G</td>
<td>North Regional Library 2nd Floor/ North Stair</td>
<td>Gray Non-Fibrous Homogeneous</td>
<td>20% Mica</td>
<td>None Detected</td>
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<tr>
<td>350803941-0019</td>
<td></td>
<td></td>
<td>80% Non-fibrous (other)</td>
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</tr>
<tr>
<td>246-HF-A WRAP</td>
<td>North Regional Library 2nd Floor/ Janitor's Closet</td>
<td>TanWhite Fibrous Layers: 2</td>
<td>90% Cellulose</td>
<td>None Detected</td>
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<tr>
<td>350803941-0020</td>
<td></td>
<td></td>
<td>10% Non-fibrous (other)</td>
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</tr>
<tr>
<td>246-HF-A INSULATION</td>
<td>North Regional Library 2nd Floor/ Janitor's Closet</td>
<td>Gray Fibrous Layers: 2</td>
<td>35% Min. Wool</td>
<td>None Detected</td>
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<tr>
<td>350803941-0020A</td>
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<td></td>
<td>65% Non-fibrous (other)</td>
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<td>246-HF-B WRAP</td>
<td>North Regional Library 2nd Floor/ Janitor's Closet</td>
<td>TanWhite Fibrous Layers: 2</td>
<td>90% Cellulose</td>
<td>None Detected</td>
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<tr>
<td>350803941-0021</td>
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<td></td>
<td>10% Non-fibrous (other)</td>
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<td>TanWhite Fibrous Layers: 2</td>
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<td>350803941-0021A</td>
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<td></td>
<td>10% Non-fibrous (other)</td>
<td></td>
</tr>
</tbody>
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Analyst(s): Erin Orthun (45)

Rachel Travis, Laboratory Manager  
or other approved signatory

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NVLAP Lab Code 20019-0

PLM-1
# Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>% Fibrous</th>
<th>% Non-Fibrous</th>
<th>Asbestos % Type</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>246-HF-C WRAP</td>
<td>North Regional Library Garage/ Janitor's Area</td>
<td>Tan/White Fibrous</td>
<td>90%</td>
<td>10% Non-fibrous</td>
<td>None Detected</td>
<td></td>
</tr>
<tr>
<td>246-HF-C INSULATION</td>
<td>North Regional Library Garage/ Janitor's Area</td>
<td>Gray Fibrous Layers: 2</td>
<td>35% Min. Wool</td>
<td>65% Non-fibrous</td>
<td>None Detected</td>
<td></td>
</tr>
<tr>
<td>310 BFT-A</td>
<td>North Regional Library 2nd Floor/ South Stair Well</td>
<td>Beige Non-Fibrous Homogeneous</td>
<td>100%</td>
<td>None Detected</td>
<td>None Detected</td>
<td></td>
</tr>
<tr>
<td>310 BFT-B FLOOR TILE</td>
<td>North Regional Library 2nd Floor/ South Stair Well</td>
<td>Beige Non-Fibrous Layers: 2</td>
<td>100%</td>
<td>Non-fibrous</td>
<td>None Detected</td>
<td></td>
</tr>
<tr>
<td>310 BFT-B MASTIC</td>
<td>North Regional Library 2nd Floor/ South Stair Well</td>
<td>Tan Non-Fibrous Layers: 2</td>
<td>100% Non-fibrous</td>
<td>None Detected</td>
<td>None Detected</td>
<td></td>
</tr>
<tr>
<td>310 BFT-C FLOOR TILE</td>
<td>North Regional Library 2nd Floor/ South Stair Well</td>
<td>Beige Non-Fibrous Layers: 2</td>
<td>100%</td>
<td>None Detected</td>
<td>None Detected</td>
<td></td>
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<tr>
<td>310 BFT-C MASTIC</td>
<td>North Regional Library 2nd Floor/ South Stair Well</td>
<td>Tan Non-Fibrous Layers: 2</td>
<td>100%</td>
<td>None Detected</td>
<td>None Detected</td>
<td></td>
</tr>
</tbody>
</table>

---

**Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. The limit of detection as stated in the method is 1%. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government. NVLAP Lab Code 200019-0**

---

This is the last page of the report.

---

*PLM-1*
Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>% Fibrous</th>
<th>% Non-Fibrous</th>
<th>Asbestos Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td>None Detected</td>
</tr>
<tr>
<td>350900256-0001</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td>None Detected</td>
</tr>
<tr>
<td>350900256-0002</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td>None Detected</td>
</tr>
<tr>
<td>350900256-0003</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyst(s)

Heidi Johnson (3)

Rachel Travis, Laboratory Manager or other approved signatory

---

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. The limit of detection as stated in the method is 1%. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government.

NVLAP Lab Code 200019-3

THIS IS THE LAST PAGE OF THE REPORT.
**Analytical Chain of Custody**

**EMSL Reference #:** 35L760 3510

<table>
<thead>
<tr>
<th>Your Company Name:</th>
<th>Street:</th>
</tr>
</thead>
<tbody>
<tr>
<td>James Jacobs (Mar. 19)</td>
<td></td>
</tr>
<tr>
<td>Box #:</td>
<td>Zip:</td>
</tr>
<tr>
<td>4405</td>
<td>MN</td>
</tr>
<tr>
<td>City/State:</td>
<td>Email Results to:</td>
</tr>
<tr>
<td>4405</td>
<td></td>
</tr>
<tr>
<td>Verbal Results to:</td>
<td>Or Fax Results #:</td>
</tr>
<tr>
<td></td>
<td>Purchase Order #</td>
</tr>
<tr>
<td>Telephone #:</td>
<td></td>
</tr>
<tr>
<td>612-2 K - 723</td>
<td></td>
</tr>
<tr>
<td>Project Name/Number:</td>
<td></td>
</tr>
<tr>
<td>1497 - 02/94</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MATRIX</th>
<th>TURNAROUND TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ar</td>
<td>Soil</td>
</tr>
<tr>
<td>Bulk</td>
<td>Dust</td>
</tr>
<tr>
<td>Water</td>
<td>water</td>
</tr>
</tbody>
</table>

**PCM**
- [ ] NIOSH 7400
- [ ] MN Dept of Health
- [ ] Other:

**PLM**
- [ ] EPA 600/R-93/116
- [ ] Comments:

**TEM AIR**
- [ ] AHERA
- [ ] EPA Level II
- [ ] NIOSH 7402
- [ ] MN Dept of Health

**TEM BULK**
- [ ] Chatfield
- [ ] NOB
- [ ] Micro Vac-Quantitative
- [ ] Micro Vac-Qualitative
- [ ] Drop Mount-Qualitative

**TEM WATER**
- [ ] EPA 100.1 (all fibers)
- [ ] EPA 100.2 (Long fibers >10um)
- [ ] NY 198.2

**TEM WIPE**
- [ ] Quantitative
- [ ] Qualitative

**TEM DUST**
- [ ] ASTM D-5755-95
- [ ] Qualitative

**Client Sample # (s)**
- Relinquished: [ ] Date: 11/20/94 Time: 9:00 AM
- Received: [ ] Date: 11/21/94 Time: 8:30 AM

<table>
<thead>
<tr>
<th>SAMPLE DATE</th>
<th>SAMPLE NUMBER</th>
<th>LOCATION</th>
<th>VOLUME (if Applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2/94</td>
<td>A</td>
<td>Above ceiling 2nd Floor</td>
<td>7 lbs</td>
</tr>
<tr>
<td>1/2/94</td>
<td>B</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>1/2/94</td>
<td>C</td>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>
**ANALYTICAL CHAIN OF CUSTODY ASBESTOS**

**EMSL Reference #:** 3567000356

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Turnaround Time</th>
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</thead>
<tbody>
<tr>
<td>Air</td>
<td>Rush 6 Hours</td>
</tr>
<tr>
<td>Bulk</td>
<td>24 Hours</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>48 Hours</td>
</tr>
<tr>
<td>Soil</td>
<td>6 Hours</td>
</tr>
<tr>
<td>Dust</td>
<td>24 Hours</td>
</tr>
<tr>
<td>Wipe</td>
<td>48 Hours</td>
</tr>
<tr>
<td>Waste</td>
<td>24 Hours</td>
</tr>
</tbody>
</table>

**PGM**
- NIOSH 7400
- MN Dept of Health
- Other:
  - Point Count (400 point)
  - Test Until Positive
  - Other:

**PLM**
- EPA 600/R-93/116
- NOB
- Other:

**TEM AIR**
- AHERA
- EPA Level II
- NIOSH 7402
- MN Dept of Health

**TEM BULK**
- Chatfield
- NOB
- Micro Vac-Quantitative
- Micro Vac-Qualitative
- Drop Mount-Qualitative

**TEM WATER**
- EPA 100.1 (all fibers)
- EPA 100.2 (Long fibers >10um)
- NY 198.2

**TEM WIPE**
- Quantitative
- Qualitative

**TEM DUST**
- ASTM D-5755-95
- Qualitative

**Client Sample # (s)**
- Relinquished: 1/26/2019 Date: 12/5/2019 Time: 9:00AM
- Received: 1/26/2019 Date: 1/26/2019 Time: 8:30AM

<table>
<thead>
<tr>
<th>SAMPLE DATE</th>
<th>SAMPLE NUMBER</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/26/2019</td>
<td>A</td>
<td>Above ceiling 2nd Flr office</td>
</tr>
<tr>
<td>1/26/2019</td>
<td>B</td>
<td>11</td>
</tr>
<tr>
<td>1/26/2019</td>
<td>C</td>
<td>11</td>
</tr>
</tbody>
</table>

**Total Samples:** 3
Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>% Fibrous</th>
<th>% Non-Fibrous</th>
<th>Asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyst(s)

Heidi Johnson (3)  
Rachel Travis, Laboratory Manager or other approved signatory
<table>
<thead>
<tr>
<th>Sample Date</th>
<th>Sample Number</th>
<th>Location</th>
<th>Volume (if Applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/30/07</td>
<td>A</td>
<td>Above ceiling 2nd Floor</td>
<td>7.20 sq ft</td>
</tr>
<tr>
<td>1/30/07</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/30/07</td>
<td>C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Appearance</th>
<th>% Fibrous</th>
<th>% Non-Fibrous</th>
<th>Asbestos Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td></td>
</tr>
<tr>
<td>J50900256-0001</td>
<td>Non-Fibrous</td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td></td>
</tr>
<tr>
<td>J50900256-0002</td>
<td>Non-Fibrous</td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Above Ceiling 2nd Floor office</td>
<td>Tan</td>
<td>15% Mica</td>
<td>85% Non-fibrous (other)</td>
<td></td>
</tr>
<tr>
<td>J50900256-0003</td>
<td>Non-Fibrous</td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyst(s)

Heidi Johnson (3)

Rachel Travis, Laboratory Manager or other approved signatory

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NVLAP Lab Code 200019-0

PLM-1

THIS IS THE LAST PAGE OF THE REPORT.
April 25, 2011

Mr. Chris McLinn
Hennepin County
A-2208 Government Center
300 South Sixth Street
Minneapolis, MN 55487-0228

Subject: Results of Bulk Material Sample Analysis
Asbestos and PCBs in Caulking Analytical Results
Hennepin County - North Regional Library
IHSC Project Number: M11-158

Dear Mr. McLinn:

Industrial Hygiene Services Corporation (IHSC) collected bulk samples of interior and exterior caulking materials for analysis of asbestos and polychlorinated biphenyls (PCBs) from Hennepin County North Regional Library, located at 1315 Lowry Avenue North in Minneapolis, Minnesota. Mr. Chris McLinn, of Hennepin County Property Services, requested IHSC’s services.

The purpose of the sampling was to update the database with respect to caulking materials at the facility. IHSC used a building survey dated July 28, 2008 prepared by Nova Consulting Group, Inc., as a guide to what caulking and other suspect asbestos containing materials had been previously analyzed for asbestos. IHSC sampled caulking materials from both the interior and exterior of the building. Maintenance personnel at the facility stated that exterior window caulk and exterior seam caulk had been replaced during the summer of 2010. He also stated that the interior of the north side of the library had been remodeled in 2004. Bulk samples of caulking materials were not collected from either of these two areas. Bulk samples were collected from the roof and upper level, south end of the library. As directed by Mr. McLinn, IHSC did not quantify sampled materials.

Bulk samples were submitted for analysis for asbestos content according to EPA Method 600/R-93/116, July 1993 utilizing polarized light microscopy and dispersion staining techniques, and for PCBs using EPA Method SW-846, 8082. Asbestos analysis was completed at EMSL Analytical, Inc. (EMSL) located in Minneapolis, Minnesota. EMSL is
accredited for asbestos analysis of building materials through the National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program (NVLAP).

PCB analysis was completed at Legend Technical Services, Inc. (Legend) located in St. Paul, Minnesota. Legend is a Certified Minnesota Environmental Laboratory through the Minnesota Department of Health, ID #027-123-295.

Results of both the asbestos and PCB sampling are provided on the attached tables. Copies of the analytical reports are also attached.

IHSC personnel who performed the survey and sampling have completed, at a minimum, an EPA-approved training course in asbestos survey and applicable refresher training courses. Copies of asbestos inspector certifications are enclosed.

The quantity of samples, sample locations, and analyses performed were selected to provide analytical data to document and evaluate current site conditions. Materials not specifically referred to in this report should be presumed to be asbestos containing until sampling and analysis proves them to be otherwise. Any discussion or recommendations contained in this report represent our professional opinions. These opinions are based on currently available information and are arrived at in accordance with currently accepted industrial hygiene practices at this time and location. Other than this, no guarantee is implied or intended.

Thank you for the opportunity to assist you. If you have any questions regarding this report or the attached results, please contact me at (651) 287-5372.

Sincerely,

INDUSTRIAL HYGIENE SERVICES CORPORATION

Amy J. Buckley
Project Manager

Attachments (5): Minnesota Department of Health Asbestos Inspector Certifications
Material Identification Table
EMSL Analytical, Inc. Test Report: Asbestos Analysis of Bulk Materials
PCBs in Caulking Material Table
Legend Technical Services, Inc. Analytical PCB Results
<table>
<thead>
<tr>
<th>Area Location</th>
<th>Room Number</th>
<th>Material ID Subcat</th>
<th>Material Identification Subcategory Description</th>
<th>Mat'l Code</th>
<th>Asbestos Content</th>
<th>Qty Unit</th>
<th>Phys.Asml. Cond</th>
<th>Damage Potential</th>
<th>Cnd Ring</th>
<th>AHERA Cat</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Regional Library 1st Floor</td>
<td>Main Area</td>
<td>313 BOSF</td>
<td>Sheet Floor &amp; Mastic Beige Sheet Floor</td>
<td>M</td>
<td>ND</td>
<td>0 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 1st Floor</td>
<td>Main Area</td>
<td>313 BLSF</td>
<td>Sheet Floor &amp; Mastic Blue Sheet Floor</td>
<td>M</td>
<td>ND</td>
<td>150 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>Janes Closets</td>
<td>246 HF</td>
<td>0+4 Fittings on Fiberglass Line</td>
<td>M</td>
<td>ND</td>
<td>6 EA</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>Large Storage Room</td>
<td>101 SOC</td>
<td>Spray-On Spray On Ceiling</td>
<td>M</td>
<td>ND</td>
<td>2000 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>Main Area</td>
<td>313 BOSF</td>
<td>Sheet Floor &amp; Mastic Beige Sheet Floor</td>
<td>M</td>
<td>ND</td>
<td>1200 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>Main Area</td>
<td>313 RSLF</td>
<td>Sheet Floor &amp; Mastic Red Sheet Floor</td>
<td>M</td>
<td>ND</td>
<td>100 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>Meeting Room A</td>
<td>101 SOC</td>
<td>Spray-On Spray On Ceiling</td>
<td>M</td>
<td>ND</td>
<td>2000 SF</td>
<td>0</td>
<td>NA</td>
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<td></td>
</tr>
</tbody>
</table>

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Table 1: Material Identification Inventory

<table>
<thead>
<tr>
<th>Area Location</th>
<th>Room Number</th>
<th>Material ID Subcat</th>
<th>Material Identification Subcategory Description</th>
<th>Mat'l Code</th>
<th>Asbestos Content</th>
<th>Qty Unit</th>
<th>Phys.Asml. Cond</th>
<th>Damage Potential</th>
<th>Cnd Ring</th>
<th>AHERA Cat</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>Meeting Room B</td>
<td>101 SOC</td>
<td>9pm-On 9pm On Ceiling</td>
<td>M</td>
<td>ND</td>
<td>2000 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>North Stair Well</td>
<td>101 SOC</td>
<td>9pm-On 9pm On Ceiling</td>
<td>M</td>
<td>ND</td>
<td>2000 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>Small Storage Room</td>
<td>310 WFT</td>
<td>12x12 Floor Tile &amp; Mastic White Floor Tile</td>
<td>M</td>
<td>ND</td>
<td>100 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>South Stair Well</td>
<td>101 SOC</td>
<td>Spray-On Spray On Ceiling</td>
<td>M</td>
<td>ND</td>
<td>2000 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library 2nd Floor</td>
<td>South Stair Well</td>
<td>310 WFT</td>
<td>12x12 Floor Tile &amp; Mastic Beige Floor Tile</td>
<td>M</td>
<td>ND</td>
<td>80 SF</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Regional Library Garage</td>
<td>Garage Area</td>
<td>246 HF</td>
<td>9+4 Fittings on Fiberglass Line</td>
<td>M</td>
<td>ND</td>
<td>2 EA</td>
<td>0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Table 2: Bulk Sample Analysis / Chain of Custody

<table>
<thead>
<tr>
<th>Project Number:</th>
<th>H08-1161</th>
<th>Client Name:</th>
<th>Michael Tupy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client Number:</td>
<td>HENN001</td>
<td>Building Name:</td>
<td>Minneapolis North Regional Library</td>
</tr>
<tr>
<td>Login Number:</td>
<td>Unassigned</td>
<td>Building Address:</td>
<td>1315 Lowry Avenue North, Minneapolis, MN 55411</td>
</tr>
<tr>
<td>Building Number:</td>
<td>Minneapolis North Regional Library</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Manager:</td>
<td>Lance Robinette</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey Date:</td>
<td>7/28/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality Control Blank:</td>
<td>Glass Filter from SRM 1616</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room Temp(C):</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampled By:</td>
<td>Joe Towner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date/Time:</td>
<td>7/28/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Received By:</td>
<td>Date/Time:</td>
<td>7/28/08</td>
<td></td>
</tr>
<tr>
<td>Date/Time:</td>
<td>7/28/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinquished By:</td>
<td>Joe Towner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date/Time:</td>
<td>7/28/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnaround Time:</td>
<td>3 Day</td>
<td></td>
<td></td>
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<tr>
<td>Due:</td>
<td>7/31/2006</td>
<td></td>
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<tr>
<td>Note:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Container Type:</td>
<td>Whirl Pak</td>
<td></td>
<td></td>
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<tr>
<td>Total Samples:</td>
<td>25</td>
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</tr>
<tr>
<td>Reporting Limit:</td>
<td>1% Asbestos</td>
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</tbody>
</table>

---

## Table 2: Bulk Sample Analysis / Chain of Custody

<table>
<thead>
<tr>
<th>Sampled Area</th>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Asbestos Fiber</th>
<th>Non-Asbestos Fiber</th>
<th>Comments/Nonfibrous Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-SOC-A</td>
<td>Spray-On</td>
<td>Spray On Ceiling</td>
<td>ND</td>
<td>80% Non-fibrous</td>
<td>20% fibros</td>
<td></td>
</tr>
<tr>
<td>101-SOC-B</td>
<td>Spray-On</td>
<td>Spray On Ceiling</td>
<td>ND</td>
<td>80% Non-fibrous</td>
<td>20% fibros</td>
<td></td>
</tr>
<tr>
<td>101-SOC-C</td>
<td>Spray-On</td>
<td>Spray On Ceiling</td>
<td>ND</td>
<td>80% Non-fibrous</td>
<td>20% fibros</td>
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</tr>
<tr>
<td>101-SOC-D</td>
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<tr>
<td>101-SOC-E</td>
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<td>Spray On Ceiling</td>
<td>ND</td>
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<tr>
<td>101-SOC-F</td>
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<tr>
<td>101-SOC-G</td>
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<td>ND</td>
<td>80% Non-fibrous</td>
<td>20% fibros</td>
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</tr>
<tr>
<td>246-SF-F</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
<td>ND</td>
<td>Depress Coarse 10% Non-fibrous</td>
<td>Hard Fitting</td>
<td>Hard Fitting</td>
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<tr>
<td>246-SF-A</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
<td>ND</td>
<td>33% Min. Wool</td>
<td>Insulation</td>
<td>65% Non-fibrous</td>
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<tr>
<td>246-SF-B</td>
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<td>Hard Fitting</td>
<td>ND</td>
<td>10% Coarse</td>
<td>Hard Fitting</td>
<td>65% Non-fibrous</td>
</tr>
<tr>
<td>246-SF-C</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
<td>ND</td>
<td>10% Coarse</td>
<td>Hard Fitting</td>
<td>65% Non-fibrous</td>
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<tr>
<td>246-SF-D</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
<td>ND</td>
<td>10% Coarse</td>
<td>Hard Fitting</td>
<td>65% Non-fibrous</td>
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<tr>
<td>246-SF-E</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
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<td>Hard Fitting</td>
<td>65% Non-fibrous</td>
</tr>
<tr>
<td>246-SF-F</td>
<td>0-4 Fittings on Fiberglass Line</td>
<td>Hard Fitting</td>
<td>ND</td>
<td>10% Coarse</td>
<td>Hard Fitting</td>
<td>65% Non-fibrous</td>
</tr>
</tbody>
</table>

C:\Documents and Settings\leah\Desktop\Nov-2008-1161 Not | ND = Not Detected | NT = Not Tested | TRAC = +1% |
Detection Limit = 1%
### Table 2: Bulk Sample Analysis / Chain of Custody

<table>
<thead>
<tr>
<th>MMB-Sub-Ltr</th>
<th>Sample Pes.</th>
<th>Area Location / Room#</th>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Friability</th>
<th>Asbestos Fibers</th>
<th>Non-Asbestos Fibers</th>
<th>Comment/ Norrhfibrous Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>310-BFT-A</td>
<td>North Regional Library 2nd Floor / South Stair Wed</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>Beige Floor Tile</td>
<td>ND</td>
<td>100% Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>310-BFT-B</td>
<td>North Regional Library 2nd Floor / South Stair Wed</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>Beige Floor Tile</td>
<td>ND</td>
<td>100% Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>310-BFT-C</td>
<td>North Regional Library 2nd Floor / South Stair Wed</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>Beige Floor Tile</td>
<td>ND</td>
<td>100% Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>310-WPT-A</td>
<td>North Regional Library 2nd Floor / Small Storage Room</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>White Floor Tile</td>
<td>ND</td>
<td>100% Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>310-WPT-B</td>
<td>North Regional Library 2nd Floor / Small Storage Room</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>White Floor Tile</td>
<td>ND</td>
<td>100% Non-Fibrous</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>310-WPT-C</td>
<td>North Regional Library 2nd Floor / Small Storage Room</td>
<td>12x12 Floor Tile &amp; Mastic</td>
<td>White Floor Tile</td>
<td>ND</td>
<td>100% Non-Fibrous</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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### Table 2: Bulk Sample Analysis / Chain of Custody

<table>
<thead>
<tr>
<th>MMB-Sub-Ltr</th>
<th>Sample Pes.</th>
<th>Area Location / Room#</th>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Friability</th>
<th>Asbestos Fibers</th>
<th>Non-Asbestos Fibers</th>
<th>Comment/ Norrhfibrous Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>311-BGF-A</td>
<td>North Regional Library 2nd Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Beige Sheet Floor</td>
<td>ND</td>
<td>10% Cellulose</td>
<td>Backing 83% Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>311-BGF-B</td>
<td>North Regional Library 2nd Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Beige Sheet Floor</td>
<td>ND</td>
<td>15% Cellulose</td>
<td>Backing 83% Non-Fibrous</td>
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<tr>
<td>311-BGF-C</td>
<td>North Regional Library 1st Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Beige Sheet Floor</td>
<td>ND</td>
<td>15% Cellulose</td>
<td>Backing 83% Non-Fibrous</td>
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<tr>
<td>311-BLSF-A</td>
<td>North Regional Library 1st Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Blue Sheet Floor</td>
<td>ND</td>
<td>15% Cellulose</td>
<td>Backing 83% Non-Fibrous</td>
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<tr>
<td>311-BLSF-B</td>
<td>North Regional Library 1st Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Blue Sheet Floor</td>
<td>ND</td>
<td>15% Cellulose</td>
<td>Backing 83% Non-Fibrous</td>
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<tr>
<td>311-BLSF-C</td>
<td>North Regional Library 1st Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Blue Sheet Floor</td>
<td>ND</td>
<td>15% Cellulose</td>
<td>Backing 83% Non-Fibrous</td>
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</tr>
<tr>
<td>311-BGT-A</td>
<td>North Regional Library 2nd Floor / Main Area</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Red Sheet Floor</td>
<td>ND</td>
<td>20% Nics</td>
<td>Backing 83% Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

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Page 3 of 5

© NCG Laboratories
<table>
<thead>
<tr>
<th>Sample Pos.</th>
<th>Area Location / Room</th>
<th>Material Description</th>
<th>Subcategory Description</th>
<th>Sample Prep</th>
<th>Fraility</th>
<th>Asbestos Fibers</th>
<th>Non-Asbestos Fibers</th>
<th>Comments/ Nonfibrous Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>J11-RSF-A</td>
<td>North Regional Library</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Red Sheet Floor</td>
<td>ND</td>
<td></td>
<td></td>
<td></td>
<td>Backing 100% Non-Asbestos</td>
</tr>
<tr>
<td>J11-RSF-B</td>
<td>North Regional Library</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Red Sheet Floor</td>
<td>ND</td>
<td></td>
<td></td>
<td></td>
<td>15% Cellulose</td>
</tr>
<tr>
<td>J11-RSF-C</td>
<td>North Regional Library</td>
<td>Sheet Floor &amp; Mastic</td>
<td>Red Sheet Floor</td>
<td>ND</td>
<td></td>
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<td>Backing 100% Non-Asbestos</td>
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<tr>
<td>J11-RSF-D</td>
<td>North Regional Library</td>
<td>Sheet Floor &amp; Mastic</td>
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<td>ND</td>
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<td>15% Cellulose</td>
</tr>
</tbody>
</table>
Certificate No: 5LM10261005IR  
Expiration Date: October 26, 2011

This is to certify that

Timothy Schmit

has attended and successfully completed an

ASBESTOS INSPECTOR

REFRESHER TRAINING COURSE

permitted by

the State of Minnesota under Minnesota Rules 4620.3702 to 4620.3722

and meets the requirements of

Section 206 of Title II of the Toxic Substances Control Act (TSCA)

conducted by

Lake States Environmental, Ltd.

in

White Bear Lake, MN on October 26, 2010

Examination Date: October 26, 2010

Lake States Environmental, Ltd

P. O. Box 645, Rice Lake, WI 54868
(800) 254-9811

Training Instructor
Certificate No: 5LM03041101IR

This is to certify that

Thomas Sogard
has attended and successfully completed an

ASBESTOS INSPECTOR
REFRESHER TRAINING COURSE
permitted by
the State of Minnesota under Minnesota Rules 4620.3702 to 4620.3722
and meets the requirements of
Section 206 of Title II of the Toxic Substances Control Act (TSCA)
conducted by

Lake States Environmental, Ltd.
in
Hudson, WI on March 4, 2011
Examination Date: March 4, 2011

Lake States Environmental, Ltd
P. O. Box 645, Rice Lake, WI 54868
(800) 254-9811

Training Instructor
# MATERIAL IDENTIFICATION TABLE

**Building Name:** Hennepin County  
North Regional Library  
1315 Lowry Avenue North  
Minneapolis, MN

**IHSC Project No.:** M11-158

**Date Sampled:** April 4, 2011

**Inspectors:** Tim Schmit and Tom Sogard

<table>
<thead>
<tr>
<th>Room ID</th>
<th>Material Identification</th>
<th>Sample Number</th>
<th>ACM Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>Flashing/Vent Caulk Gray</td>
<td>1A</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td>Flashing Caulk Dark Gray</td>
<td>2A</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td>Expansion Joint Caulk Gray</td>
<td>3A</td>
<td>None Detected</td>
</tr>
<tr>
<td>Garage</td>
<td>Door Caulk Gray</td>
<td>4A</td>
<td>None Detected</td>
</tr>
<tr>
<td></td>
<td>Seam Caulk Light Gray</td>
<td>5A</td>
<td>None Detected</td>
</tr>
<tr>
<td>East Hallway</td>
<td>Door Caulk White</td>
<td>6A</td>
<td>None Detected</td>
</tr>
<tr>
<td>2nd Floor, Men's Restroom</td>
<td>Window Caulk Brown</td>
<td>7A</td>
<td>None Detected</td>
</tr>
</tbody>
</table>

ND = No asbestos detected in the portion of sample submitted for analysis.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
<th>Appearance</th>
<th>Non-Asbestos Percentage</th>
<th>Asbestos Percentage</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>040411-1A</td>
<td>Gray Flashing/Vent Caulk, Roof</td>
<td>Gray</td>
<td>5% Cellulose</td>
<td>90% Non-fibrous</td>
<td>None Detected</td>
</tr>
<tr>
<td>35110750-0001</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>040411-2A</td>
<td>Dark Gray Flashing Caulk, Roof</td>
<td>Black</td>
<td>2% Cellulose</td>
<td>98% Non-fibrous</td>
<td>None Detected</td>
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<tr>
<td>35110750-0002</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
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<tr>
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<td></td>
<td>Heterogeneous</td>
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<tr>
<td>040411-3A</td>
<td>Gray Expansion Joint Caulk, Roof</td>
<td>Gray</td>
<td>5% Synthetic</td>
<td>95% Non-fibrous</td>
<td>None Detected</td>
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<td>35110750-0003</td>
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<td>Non-Fibrous</td>
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<td></td>
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<td></td>
<td>Heterogeneous</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>040411-4A</td>
<td>Gray Door Caulk, Garage</td>
<td>Gray</td>
<td>2% Cellulose</td>
<td>98% Non-fibrous</td>
<td>None Detected</td>
</tr>
<tr>
<td>35110750-0004</td>
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<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>040411-5A</td>
<td>Light Gray Seam Caulk, Garage</td>
<td>Gray</td>
<td>2% Cellulose</td>
<td>98% Non-fibrous</td>
<td>None Detected</td>
</tr>
<tr>
<td>35110750-0005</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>040411-6A</td>
<td>White Door Caulk, East Hallway</td>
<td>White</td>
<td>2% Cellulose</td>
<td>98% Non-fibrous</td>
<td>None Detected</td>
</tr>
<tr>
<td>35110750-0006</td>
<td></td>
<td>Non-Fibrous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterogeneous</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial report from 04/11/2011 13:03:32

Analyst(s)  
Nicholas Asuncion (7)

Rachel Travis, Laboratory Manager or other approved signatory

EMSL maintains lab by limited to cost of analysis. This report relates only to the samples reported and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-fusible organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Min NVLAP Lab Code 200045-0

Attn: Amy Buckley  
Industrial Hygiene Services Corporation  
4205 White Bear Parkway  
Suite 500  
Vadnais Heights, MN 55110  
Fax: (651) 766-9822  
Phone: (651) 766-9811  
Project: M11-155, North Regional Library  

Customer ID: IHSC80  
Customer PO:  
Received: 04/06/11 10:50 AM  
EMSL Order: 351101750  
EMSL Proj:  
Analysis Date: 4/11/2011  


<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
<th>Appearance</th>
<th>% Fibrous</th>
<th>% Non-Fibrous</th>
<th>% Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>040411-7A</td>
<td>Brown Window Caulk, 2nd Fl. Mens Restroom</td>
<td>Black Non-Fibrous Heterogeneous</td>
<td>2% Cellulose 98% Non-fibrous (other)</td>
<td>None Detected</td>
<td></td>
</tr>
<tr>
<td>351101750-0007</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Initial report from 04/11/2011 13:03:32

Analyst(s)

Nicholas Asuncion (7)  

Rachel Travis, Laboratory Manager  
or other approved signatory

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Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn NVLAP Lab Code 2000190


THIS IS THE LAST PAGE OF THE REPORT.
## Chain-of-Custody Record

**ISC Project No:** 111-158  
**Project Manager:** Amy Buckley  
**Project Name:** North Regional Library  
**Project Location:** Minneapolis, MN  
**Sample ID:**  
**Sample Location Description:**  
**Date/Time Sampled:**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Sample Location Description</th>
<th>Date/Time Sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>040411-1A</td>
<td>Gray Flash/vent caulk Rust</td>
<td>4-4-11</td>
</tr>
<tr>
<td>2A</td>
<td>Dark gray Flash caulk Rust</td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td>Gray expansion joint caulk Rust</td>
<td></td>
</tr>
<tr>
<td>4A</td>
<td>Gray door caulk Garage</td>
<td></td>
</tr>
<tr>
<td>5A</td>
<td>Light gray seam caulk Garage</td>
<td></td>
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<tr>
<td>6A</td>
<td>White door caulk East hallway</td>
<td></td>
</tr>
<tr>
<td>7A</td>
<td>Brown window caulk 2nd fl East</td>
<td></td>
</tr>
</tbody>
</table>

**Analysis Requested:**

- [ ] A  
- [x] B  
- [ ] C  
- [ ] D  
- [ ] E  
- [ ] F  
- [ ] G  
- [ ] H  
- [ ] I  
- [ ] J  
- [ ] K  
- [ ] L  
- [ ] M  
- [ ] N  
- [ ] O  
- [ ] P  
- [ ] Q  
- [ ] R  
- [ ] S  
- [ ] T  
- [ ] U  
- [ ] V  
- [ ] W  
- [ ] X  
- [ ] Y  
- [ ] Z  
- [ ] Other:

**Sample Condition as Received:**  
- Chilled: Yes/No  
- Sealed: Yes/No  
- Sample Condition Comments:  

**General Comments:** Results to Amy Buckley  

**Relinquished by:** [Signature]  
**Company:** HSC  
**Date:** 4-4-11  

**Received by:** [Signature]  
**Company:**  
**Date:**  

**Relinquished by:** [Signature]  
**Company:**  
**Date:**  

**Received by:** [Signature]  
**Company:**  
**Date:**  

**Relinquished by:** [Signature]  
**Company:**  
**Date:**  

**Received by:** [Signature]  
**Company:**  
**Date:**  

**Sample Number:**  

**Total Number of Containers:** 7
PCBs in Caulking Materials

Building Name: Hennepin County
North Regional Library
1315 Lowry Avenue North
Minneapolis, MN

IHSC Project No.: M11-158

Date Sampled: April 4, 2011

Inspectors: Tim Schmit and Tom Sogard

<table>
<thead>
<tr>
<th>Date of Sampling</th>
<th>Sample ID</th>
<th>Location/Material Description</th>
<th>Approximate Quantity</th>
<th>Analytical Results (mg/kg)*</th>
<th>RL (mg/kg)</th>
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<tbody>
<tr>
<td>04/04/11</td>
<td>PCB-1</td>
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<td>PCB-5</td>
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<td>PCB-6</td>
<td>2nd Floor Men’s Restroom - Brown Window Caulk</td>
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The species of PCBs analyzed for each sample includes: Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254 and Aroclor 1260. Only those with results above detectable levels are noted.

*=Aroclor 1424 and Aroclor 1260 results presented.

As required by the Minnesota Pollution Control Agency, caulking containing PCBs at a concentration greater than 50 ppm shall be managed as a hazardous waste.

mg/kg = milligrams per kilogram, equivalent of parts per million (ppm)
RL = analytical reporting limit
Bold Results = PCB Concentrations >50 ppm
April 13, 2011

Ms. Amy Buckley
Industrial Hygiene Services Corporation
4205 White Bear Parkway, Suite 500
Vadnais Heights, MN 55110

Work Order Number: 1101415
RE: PCB in Caulk

Enclosed are the results of analyses for samples received by the laboratory on 04/04/11. If you have any questions concerning this report, please feel free to contact me.

All samples will be retained by LEGEND, unless consumed in the analysis, for 30 days from the date of this report and then discarded unless other arrangements are made.

MDH Certification #027-123-295

Prepared by
LEGEND TECHNICAL SERVICES, INC

Bach Pham
Client Manager I
bpham@legend-group.com

Terri Olson
Report Reviewer
tolson@legend-group.com

Legend Technical Services, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.
### ANALYTICAL REPORT FOR SAMPLES

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### Shipping Container Information

- **Temperature**: Temperature blank was not present
- **Temperature**: Ambient: Yes
- **Accepted (IH/ISO only)**: No
- **Received on ice pack**: No
- **Received on melt water**: No

### Case Narrative:

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.
### PCB 8082

**Legend Technical Services, Inc.**

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<th>Analyte</th>
<th>Result</th>
<th>RL</th>
<th>MDL</th>
<th>Units</th>
<th>Dilution</th>
<th>Batch</th>
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<th>Method</th>
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### PCB 8082
Legend Technical Services, Inc.

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<th>Analyte</th>
<th>Result</th>
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<th>MDL</th>
<th>Units</th>
<th>Dilution</th>
<th>Batch</th>
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The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.
## PCB 8082 - Quality Control
Legend Technical Services, Inc.

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Legend Technical Services, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.
### Notes and Definitions

S-04  The surrogate recovery for this sample is outside of established control limits due to a sample matrix effect.

<  Less than value listed

dry  Sample results reported on a dry weight basis

NA  Not applicable. The %RPD is not calculated from values less than the reporting limit.

MDL  Method Detection Limit

RL  Reporting Limit

RPD  Relative Percent Difference

LCS  Laboratory Control Spike = Blank Spike (BS) = Laboratory Fortified Blank (LFB)

MS  Matrix Spike = Laboratory Fortified Matrix (LFM)
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<td>-2</td>
<td>Gray expansion joint cash, roof</td>
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<td>-3</td>
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<td>Gray door cash Garage</td>
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<td>-6</td>
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**CSE REQUEST TRANSMITTAL TO PROPERTY SERVICES**

**Attention:** Deann Beard / mail code 228 / Tel: 812-348-5913

**Date:** 3/22/2011

**Proposal Number:**

**Proposal amount:** $3,700.00

**Reimbursables:**

**TOTAL AMOUNT:** $3,700.00

**Vendor Information**

- **Vendor Name:** Industrial Hygiene Services Corp
- **Contact Name:** Amy Buckley
- **Contact TEL:** 812-766-9811
- **End Date:** 4/29/11

**User Dept. / Project Manager:** Chris McLinn, EHS Specialist, Workplace Safety

**Signature:** Chris McLinn

**User Dept Section Manager:** NA

**Signature:**

**Vendor Firm Selection Criteria:**
- [ ] Designer selection process (Multiple firms)
- [ ]Continuation of Work
- [ ] Best Choice for Scope
- [ ] Familiarity With Facility
- [ ] Specialty Work
- [ ] New Firm
- [ ] Equitable Opportunity

**Split %**

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<th>Account</th>
<th>Business Unit</th>
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<td>D21728</td>
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<td>CSLOS</td>
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**Project Title:** ACM Resurvey and PCB Caulking Survey at North Regional Library

**Building Name:** North Regional Library

**Building Manager:** Kays Lucas

**Telephone Number:** 812-348-2754

**Description / APEX Requisition Name:** Summary - ONLY 30 character for APEX

See attached proposal.

**SERVICES AUTHORIZED:**

- [ ] PROGRAMMING
- [ ] CONSTRUCTION CONTRACT ADMINISTRATION
- [ ] CONSTRUCTION CONTRACT ADMINISTRATION
- [ ] RECORD DRAWINGS
- [ ] INTRODUCTION DESIGN SERVICES
- [ ] PREPARATION OF ALTERNATIVES
- [ ] SERVICES OF SUBCONSULTANTS
- [ ] PREPARATION OF CHARGE ORDERS
- [ ] COST ESTIMATE
- [ ] CONSTRUCTION DOCUMENTS
- [ ] ANALYSIS / SPECIAL STUDIES / REVIEW
- [ ] OTHER
- [ ] PLANNING SURVEY / SITE EVALUATION

**INSURANCE VERIFICATION:**

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<tr>
<td>Work Compensation</td>
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<td>Professional Liability</td>
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Consultant has insurance on file: [ ] Yes [ ] No

**Contract Number:** A101972

**APEX Requisition Number:**

**APEX - P.O. Number:** 55732

**Revised:** 6/28/10

**Receipt:** 3/23/11

**FINANCIAL SERVICES**

All work must be coordinated with Chris McLinn.
CSA REQUEST TRANSMITTAL TO PROPERTY SERVICES

Attention: Deann Beard / mail code 228 / Tel: 612-348-5913

Date: 3/22/11

Proposal Number

Proposal amount: $3,700.00
Reimbursable: TOTAL AMOUNT: $3,700.00

Requestor: Michael Tupy
User Department: Property Services
Division Name: Workplace Safety and Environmental Division

User Dept / Project Manager: Chris McLinn, EHS Specialist, Workplace Safety
Signature: Chris McLinn
Manager: NA

Vendor information
Vendor Name: Industrial Hygiene Services Corp
Contact Name: Amy Buckley
TEL: 651-766-9911
End Date: 4/23/11

Project Title: ACM Resurvey and PCB Caulking Survey at North Regional Library
Building Name: North Regional Library
Building Manager: Keye Lucey
Telephone Number: 612-348-2738

Description / APEX Regulation Name: Summary - ONLY 30 characters for APEX
See attached proposal.

SERVICES AUTHORIZED:

- PROGRAMMING
- CONSTRUCTION CONTRACT ADMINISTRATION
- RECORD DRAWINGS
- INTERIOR DESIGN SERVICES
- CONSTRUCTION DOCUMENTS
- ANALYSIS / SPECIAL STUDIES / REVIEW
- CONSTRUCTION DOCUMENTS
- PLANNING SURVEY / SITE EVALUATION
- RECORD DRAWINGS
- INTERIOR DESIGN SERVICES
- CONSTRUCTION DOCUMENTS
- PLANNING SURVEY / SITE EVALUATION
- RECORD DRAWINGS
- INTERIOR DESIGN SERVICES
- CONSTRUCTION DOCUMENTS
- PLANNING SURVEY / SITE EVALUATION
- RECORD DRAWINGS
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- RECORD DRAWINGS
- INTERIOR DESIGN SERVICES
- CONSTRUCTION DOCUMENTS
- PLANNING SURVEY / SITE EVALUATION

INSURANCE VERIFICATION:
Policy
General Liability
Automobile Liability
Workers Compensation
Professional Liability
Expiration Date

Contact/Has Insurance on file

Contract Number: A101972
APEX Requisition Number: APEX - P.O. Number: 55732 (3-30-11)

Approved

R:VA2208 PSDesign & Construction\Consultants\Templates\CSA Request Transmittal revised 12/30/2010 APEX.xls|CSA Trans. Req.
Date: 3/22/21
Proposal Number: 
Proposal Amount: $3,700.00
Reimbursable: 
TOTAL AMOUNT: $3,700.00

Requestor: Michael Tupy
User Department: Property Services
Division Name: Workplace Safety and Environmental Division

Vendor Information
Vendor Name: Industrial Hygiene Services Corp
Contact Name: Amy Buckley
TEL: 851-766-9800
End Date: 4/29/11

User Dept / Project Manager: Chris McLinn, EHS Specialist, Workplace Safety
Department Manager: Michael Tupy, Sr Admin Manager, Workplace Safety

Signature: Chris McLinn
User Dept Section Manager: NA
Signature: 

Vendor Firm Selection Criteria: (check one)
☐ Designer selection process (Multiple firms)
☐ Continuation of Work
☐ Best Choice for Scope
☐ Familiarity With Facility
☐ Specialty Work
☐ Equitable Opportunity
☐ New Firm

Splits %
100%

Fund Date
55
990100
5210

Account
Business Unit
PROPS

Proj Number
$31729

Activity
NCBL

Source Type
CSLOS

Category

Project Title: ACM Resurvey and PCB Caulking Survey at North Regional Library

Building Name: North Regional Library
Building Manager: Kaye Lucey
Phone Number: 812-348-2724

Description / APEX Requisition Name: Summary - ONLY 30 character for APEX
See attached proposal.

APPROVED

SERVICES AUTHORIZED:
☐ PROGRAMMING
☐ CONSTRUCTION DOCUMENTS
☐ DESIGN DEVELOPMENT
☐ CONSTRUCTION DOCUMENTS
☐ RECORD DRAWINGS
☐ PREPARATION OF ALTERNATIVES
☐ PREPARATION OF CHANGE ORDERS
☐ INTERIOR DESIGN SERVICES
☐ SERVICES OF SUBCONSULTANTS
☐ COST ESTIMATE
☐ OTHER

INSURANCE VERIFICATION:
Policy
General Liability
Automobile Liability
Work Compensation
Professional Liability

Consultants Insurance on file
☐ YES
☐ NO

Contract Number: A101972
APEX Requisition Number: 
APEX - P.O. Number: 55732

R:\VA2208 PSDesign & Construction\Consultant\Templates\CSA Request Transmittal revised 12/20/2010 APEX.xls|CSA Trans. Req.
SECTION 00 72 13

GENERAL CONDITIONS

PART 1 – GENERAL

1.1 SUMMARY

A. General Conditions of the Contract, Stipulated Sum, Single Prime.

B. Owner modified General Conditions of the Contract for Construction, AIA Document A201, 2017 Edition, are incorporated into this Project Manual by reference and attachment. This document has been electronically modified by the Owner, to include Supplementary Conditions to the General Conditions of the Contract. An original copy of this Owner modified AIA A201, 2017 is also available for viewing by Proposers at Dodge Data & Analytics; Minnesota Builders Exchange; ConstructConnect; AGC of Minnesota; NAMC (National Association of Minority Contractors); and the office of the Architect, Bentz/Thompson/Rietow, Inc., 900 Second Avenue South, Suite 400, Minneapolis, MN 55402.
Insert AIA Document A201 – 2017 (HC-Modified)
PART 1 – GENERAL

1.1 SUMMARY

Supplementary Conditions affecting the General Conditions of the Contract for Construction apply to this project, and have been written into the Owner modified American Institute of Architects (AIA) Document A201, 2017 Edition. Refer to SECTION 00 72 13 - GENERAL CONDITIONS.

The following conditions may change, delete from or add to the Owner modified "General Conditions of the Contract for Construction", AIA Document A201, 2017 Edition, and shall take precedence over the General Conditions. Where any article of the General Conditions is modified or any paragraph, subparagraph or clause thereof is modified or deleted by these Supplementary Conditions, the unaltered provisions of that article, paragraph, subparagraph or clause shall remain in effect.

Re: 8.4 LIQUIDATED DAMAGES

Change the first two sentences of Subparagraph 8.4.1 to read as follows:

8.4.1 “Time being an essential element of the Contract, and based on the Project Schedule of Substantial Completion within 300 calendar days from the date of Notice to Proceed, it is hereby agreed that if the Owner determines that an extension is not justified, the Owner will be entitled to damages for failure on the part of the Contractor to complete its obligations. In view of the impracticality and extreme difficulty of fixing and ascertaining the actual damages the Owner would sustain in such event, the Owner shall be entitled to Five Hundred and No/100 dollars ($500.00) per calendar day for each and every day beyond the date of Substantial Completion in these specifications by November 20, 2020. “

Add to the second paragraph of Subparagraph 8.4.1 the following Hennepin County Project Manager and contact information, to read as follows:

“A . . . A claim for extension will not be allowed unless the Contractor, not later than the end of the Owner’s first business day following the day on which the claim arises, shall have emailed and informed the Hennepin County Project Manager, (Lisa Bartels) at (lisa.bartels@hennepin.us) about the full details of the cause necessitating such a claim. . . . “

Re: 9.3 APPLICATIONS FOR PAYMENT

Add the following new Subparagraph 9.3.1.9 to read as follows:

§9.3.1.9 The Contractor will permit SBE Subcontractors, as defined below, to submit an Application for Payment on a bi-weekly basis. Additionally, Contractor shall:
a) review such Application for Payment and include the total uncontested amount stated therein in an Application for Payment to Owner, without retaining against the materials and equipment portion of such requested amount;
b) submit Applications for Payment to the Owner on a bi-weekly basis;
c) notify SBE Subcontractors that they may submit the following on a bi-weekly basis:
   (1) Applications for Payment that include the cost for materials and equipment purchases, but not yet installed, if such materials and equipment were included in a submittal approved by Owner and are included in an executed purchase order with a supplier;
   (2) Submittals covering materials and equipment, for Owner’s review and approval;
d) Make payment within ten (10) days to an SBE Subcontractor after receipt of payment for Owner of the uncontested amount stated in the SBE Subcontractor’s Application for Payment.

‘SBE Subcontractor’ means a Subcontractor certified as a Small Business Enterprise (SBE) by the Central ‘CERT’ Program.

Re: 9.8 SUBSTANTIAL COMPLETION

Add the paragraph 9.8.6 regarding Acceptance Testing:

§ 9.8.6 Notwithstanding anything in this Contract to the contrary, before a Certificate of Substantial Completion can be prepared by the Architect for the Owner and Contractor, the Contractor shall be required to complete and correct any testing, documentation (test results), and receive Architect approval (Acceptance Testing) that the Work conforms to the performance standards in the Contract Documents. The Acceptance Testing shall be completed over a period of time as defined in the Contract Documents and corrections shall be made as required. Corrections made during the Acceptance Testing period may reset the testing period to ensure conformance to the performance standards to the satisfaction of the Architect. The direct cost or any associated cost for the testing and retesting shall be the responsibility of the Contractor and shall not cause any adjustment to the Contract Sum.

RE: 13.7 – HENNEPIN COUNTY SMALL BUSINESS ENTERPRISE (SBE) PROGRAM

§ 13.7.8 SMALL MINORITY-OWNED BUSINESS ENTERPRISE (SMBE) AND SMALL WOMEN-OWNED BUSINESS ENTERPRISE (SWBE) PROGRAM

§ 13.7.8.1 Hennepin County is committed to providing equal opportunity in contracting and to a goal of increased participation of SMBE and SWBE firms in contracting and subcontracting. These goals are on the project’s scope of work coupled with an assessment by the County of available SMBE and SWBE firms. If the amount of the Proposer’s Total Base Cost exceeds $100,000, the Proposer must complete, sign and submit a Hennepin County Subcontractor Participation Form (Exhibit 2) within one (1) business day following Proposer’s submission of its Proposal. The Contract will not be awarded unless the required Subcontractor Participation Form is approved by the County or a written exemption. A Proposer that does not meet the SMBE and SWBE goals must submit its good-faith efforts documentation, as described in Article 13.7.
The SMBE and SWBE goals for this project are:

**SMBE Goal:** 11%

**SWBE Goal:** 16%

**A. Small Minority Business Enterprise (SMBE):** means a CERT certified small minority owned business, which is a continuing, independent, for profit business which performs a commercially useful function, and is at least 51 percent owned and controlled by one or more minority individuals, and whose management and daily business operations are controlled by one or more such individuals. Minority-owned businesses include male and female owned firms that are African American, Hispanic, Asian, or Native American as classified by CERT.

**B. Small Women Business Enterprise (SWBE):** means a CERT certified small women-owned business, which is a continuing, independent, for profit business which performs a commercially useful function, and is at least 51 percent owned and controlled by one or more women, and whose management and daily business operations are controlled by one or more such individuals. Women-owned firms are firms that are White/Caucasian as classified by CERT.

§ 13.7.8.2 A Proposer that does not meet the SMBE and SWBE goals and is found to have made insufficient good-faith efforts will be deemed non-responsive and its proposal will be rejected.

§ 13.7.8.2 After start of work, Contractors are required on a monthly basis to submit a Summary of Payment Form, to document payments, through B2GNow, the County’s online contract compliance system.

Re: 13.9 LABOR STANDARDS PROVISIONS. Delete Subparagraph 13.9.5.
PART 1 – GENERAL

1.1 SUPPLEMENTARY OWNER FORMS SUPPORTING THE CONTRACT

Supplementary Owner Forms are hereby attached as may support the Work. The Contractor shall use these informational, affidavit, and reporting forms to execute requirements of the General Conditions of the Contract for Construction.

See the following pages for typical Project Forms.

A. Good Faith Efforts Guidelines
B. PS Contractor’s Summary of Payment
C. Project Safety & Environment Checklist
D. Hot Work Permit
E. Confined Space Entry Permit
F. Employee Security Background Checks
G. Responsible Contractor Verification of Compliance Forms A, A-1, and A-2
H. Prevailing Wage Rates. See attached Hennepin County Prevailing Wage Rates
GOOD FAITH EFFORTS

As a government contractor your company shall make and document reasonable efforts to include qualified CERT certified small business enterprises (SBEs) – including companies owned and controlled by women (S/WBEs) and minorities (S/MBEs). A list of certified businesses can be obtained by visiting the CERT website at: cert.smwbe.com. Good faith efforts should not be an afterthought. If established goals are not met, Hennepin County will make the final determination as to whether sufficient good faith efforts to achieve the goals were made. Good faith is determined by the totality of circumstances and based on the quantity, quality, and timeliness of applicable efforts.

TARGETED BUSINESS INCLUSION GUIDELINES

Good faith efforts to provide the maximum practicable subcontracting opportunities for small business concerns may include, as appropriate for the procurement, the following types of actions and documentation thereof:

1) Breaking out contract work requirements into economically feasible units, as appropriate, to facilitate small business participation;

2) Searching for applicable CERT certified small businesses to include in contract opportunities and encouraging other qualified businesses to apply for CERT certifications;

3) Soliciting small business concerns as early in the acquisition process as practicable;

4) Keeping the playing field level, allowing all bidders equal time to respond; providing the same information to all prospective subcontractors at the same time;

5) Providing interested small businesses with adequate and timely information about the plans, specifications, and requirements for performance of the prime contract to assist them in submitting a timely offer for the subcontract;

6) Negotiating in good faith with interested small businesses;

7) Attending pre-bid conferences;

8) Participating in or sponsoring business networking events;

9) Utilizing the available services of small business associations; local, state, and federal small business assistance offices; and other organizations;

10) Directing small businesses that need additional assistance to community resources, e.g., Minnesota Small Business Assistance Office; Metropolitan Economic Development
Association (MEDA) Procurement Technical Assistance Center (PTAC); U.S. Small Business Administration (SBA); SCORE; LegalCORPS; WomenVenture, etc.;

11) Assisting interested small businesses in obtaining bonding, lines of credit, required insurance, necessary equipment, supplies, materials, or services;

12) Participating in the formal mentor-protégé program with one or more small business protégés that results in developmental assistance to the protégé(s);

13) Targeting advertising and posting of subcontracting opportunities;

14) Encouraging joint ventures and mentor/protégé relationships;

15) Providing technical, management and financial training and counseling;

16) Notifying firms that trade union membership is not a contract requirement, but payment of prevailing wage rates is;

17) Documenting solicitation processes, responses and results, e.g., work type/description of work/service/material, firm name, contact name (first and last), contact date, contact method (if by phone provide phone number, if by email…), bid amount, result, and additional comments;

18) Submitting complete, accurate and timely documents, reports and other information as required, and

19) Offering debriefings to unsuccessful small business respondents.

THE GUIDELINES ABOVE ARE NOT INTENDED TO BE A MANDATORY CHECKLIST, NOR ARE THEY INTENDED TO BE EXCLUSIVE OR EXHASUTIVE. OTHER FACTORS OR TYPES OF EFFORTS MAY BE RELEVANT. ALL DOCUMENTATION RELATED TO GOOD FAITH EFFORTS MUST BE COLLECTED AND MAINTAINED IN YOUR FILES FOR AT LEAST TWO (2) YEARS.
## Summary of Payment Form
### Contractor Pay Disbursement

**PROJECT NAME:**

County Project Number: ___________________

County Contract No. #: ___________________

This form is being sent along with current Pay Applic. #: ______; however, this form applies to previous Pay Applic. #______, work period to: (match prev. G702) ____/____/____

**CONTRACTOR:**

________________________________________

Address:

_____________________________________

County Project Number: ___________

County Contract No.#: ___________

Address: __________________________________

This form is being sent along with current Pay Applic. #: _____; however, this form applies to previous Pay Applic. #______, work period to: (match prev. G702) ____/____/____

<table>
<thead>
<tr>
<th>Work Section</th>
<th>Description of Work</th>
<th>Subcontractor Name</th>
<th>Subcontractor Portion</th>
<th>Contractor Portion</th>
<th>Line Item Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

**Period’s Distribution Total =**

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g.\]

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- **Expand schedule as needed, using MS Word “Table” insert commands** -

Helpful column use comments:

a. Numeric order of Work, by CSI division. List is to match that order used in AIA form G703.

b. Ordered Description of Work, by CSI division. Match order of G703 & corresponding column ‘a’.

c-e. No explanation req’d.

d. Sum of (d. + e.) monies, per each line item entry, as distributed by Contractor, from Owner’s approved payment on the last Application.

e. Add vertical column of subtotals ‘f’. Must equal Owner’s approved dollar total from the previous period’s Payment Application, as numbered above at top.

The undersigned Contractor affirms & certifies that to the best of his/her knowledge, information on this page is true and correct, and acknowledges that the Architect and the Owner will rely on said information when authorizing payment. This is a legal statement, and has legal consequences.

___________________________________________

Name, & Title

/    /

Date

---

C. PS Contractors Summary of Payment

L. Rev 10/05

Project Safety Checklist

The Contractor shall use this checklist to identify and address health, safety and environmental issues that may be encountered or created during this project, prior to start of work. Submit the completed checklist to ps.wse.mail@hennepin.us in accordance with Article 10 of the General Conditions of the Contract. An electronic form/copy can be found at http://www.hennepin.us/business/work-with-henn-co/contracting-with-hennepin-county.

Project Name: ___________________________ County Project No.: ___________________________

General Contractor: ___________________________

Contractor Site Mgr.: ___________________________ Office Phone: ___________________________

Email: ___________________________ Cell Phone: ___________________________

Contractor Safety Mgr.: ___________________________ Office Phone: ___________________________

Email: ___________________________ Cell Phone: ___________________________

Start Date: ___________________________ Est. Completion Date: ___________________________

Work in occupied facilities must be coordinated with the County Project Manager and Facility Manager. Dust and odors shall be contained in the work zone unless exempted in writing by the County Project Manager. Activities that may affect fire alarms must be coordinated with the Facility Manager and County Project Manager. The jobsite, workplace safety, codes, and regulations are the responsibility of the Contractor within the project scope of work. Hennepin County Facility Services staff may request additional supportive safety documentation regarding this project.

Issue that may be disruptive to site occupants. Is the issue likely to occur? Have means & methods been developed to eliminate or control the issue?

Will work performed in or adjacent to occupied facilities Yes ☐ No ☐

Odors (adhesives, solvents, caulks, paint, welding, cutting, engine exhaust, etc.) Yes ☐ No ☐

Dust (sanding, cutting, demolition work, etc.) Yes ☐ No ☐

Noise (pneumatic tools, core drilling, etc.) Yes ☐ No ☐

Fire / Life Safety (access/ egress) Yes ☐ No ☐

Hazardous materials (silica, asbestos, lead, mold, etc.) Yes ☐ No ☐

Site hazard control (signs, barriers, security, etc.) Yes ☐ No ☐

Service Interruptions:
- Fire Suppression/ Alarm Systems Yes ☐ No ☐
- HVAC Yes ☐ No ☐
- Communication (Phone/ Data) Yes ☐ No ☐
- Electrical Yes ☐ No ☐
- Lighting Yes ☐ No ☐
- Sewer/ Water Yes ☐ No ☐
- Other Yes ☐ No ☐

Environmental Protection: On-site containment and off-site disposal of hazardous materials must be coordinated with the Facility Manager and County Project Manager. Where previously unidentified hazardous materials or suspect hazardous materials are encountered during the project, stop work and promptly contact the County Project Manager and Chris McLinn. Chris can be contacted at 612-490-6349 or at christopher.mclinn@hennepin.us.

Facility Permits: All Hot Work, Work in Confined Spaces and Live Electrical Work requires prior coordination with the Facility Manager and County Project Manager. Submit Hennepin County Hot Work, Confined Space Entry and Live Electrical Work forms, as appropriate, to Facility Manager before the start of the work. The Facility Manager is responsible for insurance company notification requirements where the fire alarm system has been disabled because of Hot Work. When these permits apply to the work, Contractor’s failure to comply with this permit process may result in a suspension of the work by the Owner.

Completed by (print name): ___________________________

Job Title: ___________________________

General Contractor Company: ___________________________

Date: ___________________________

Workplace Safety 9/17
Hennepin County Hot Work Permit

**NOTE:** Hennepin County requires Hot Work Permits to be completed for all welding, cutting, or other work that involves open flames or sparks, unless such work takes place in a designated welding area.

<table>
<thead>
<tr>
<th>HOT WORK PERMIT IDENTIFICATION:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hennepin County Building Name:</td>
<td>Date /Time Hot Work to Begin and End (one day maximum – new permit required daily):</td>
</tr>
<tr>
<td>Location where work will be performed (Floor/Room#):</td>
<td>Contractor Company Name:</td>
</tr>
<tr>
<td>Hennepin County Permit Authorizing Individual Name</td>
<td>Hot Work Supervisor Name:</td>
</tr>
<tr>
<td>HC Permit Authorizing Individual Phone Number:</td>
<td>Hot Work Supervisor Phone Number:</td>
</tr>
<tr>
<td>HC Permit Authorizing Individual Signature/Date:</td>
<td>Hot Work Supervisor Signature/Date:</td>
</tr>
</tbody>
</table>

The HC Permit Authorizing Individual and the Hot Work Supervisor must review and certify that they will manage the risk of fire associated with hot work. By signing this permit, they certify that hot work shall be performed in accordance with the Required Precautions Checklist shown on Page 2.

**HOT WORK PERMIT SPECIFICATIONS:**

Description of Hot Work to be Performed (be specific):

Equipment to be Used:

- Electric Arc Welding
- Gas Welding
- Cutting
- Soldering
- Grinding
- Brazing
- Thawing
- Torch Applied Roofing
- Other (specify) _______________________________

**POST THIS PERMIT AT HOT WORK LOCATION**

Fax copy of completed Hot Work permit to Hennepin County Workplace Safety at 612-348-3492

*(Revised 08/2018)*

In case of an emergency, contact the Security Operations Center at 612-348-5111.
### REQUIRED PRECAUTIONS CHECKLIST:

The Hennepin County Permit Authorizing Individual and the Hot Work Supervisor must review and perform hot work in accordance with required precautions shown on this checklist.

#### Fire Systems and Equipment
- Sprinkler system is in service and an operable fire extinguisher is nearby work area.
- Workers have been instructed on fire protection and evacuation procedures.
- Fire detection systems have been impaired as necessary to prevent false alarms.
- HC Security Operations Center has been notified that hot work will be performed.
- AIG “Fire Protection Out of Service” Tag has been filled out for any impairment.
- AIG have been notified before fire system impairment starts. 1-877-705-7287
- AIG will be notified after fire system is restored to normal. 1-877-705-7287

#### Requirements Within 35 ft of Hot Work
- Combustibles have been removed or covered with fire-resistant material.
- All wall and floor openings covered with fire-resistant material.
- Flammable liquids, dust, lint and oily deposits removed.
- Explosive atmosphere in area eliminated.
- Floors have been swept clean and trash removed.

#### Hot Work on Walls, Ceilings or Roofs
- Check for noncombustible construction and cover combustible building parts.
- Check for combustibles on other side of walls, ceilings or roof.

#### Hot Work on Enclosed Equipment
- Enclosed equipment cleaned of all combustibles.
- Containers and pressurized piping purged of flammable liquids/vapors.
- Equipment has been removed from service and isolated. (LOCKOUT TAGOUT)

#### Fire Watch/Hot Work Area Monitoring
- Fire watch will be provided during and for at least 1 hour after work is completed.
- Fire watch is supplied with an appropriate fire extinguisher.
- Fire watch is trained in use of equipment and in sounding alarm.
- Additional fire watch is provided for adjoining area above and below, as needed.
- HC Security Operations Center (612-348-5111) will be notified when hot work is completed.
- Hot work area will be monitored for 3 hours after the job is finished.

#### Other Precautions:

(Revised 08/2018)
**NOTE:** Insurance requires that this form be filled out prior to any fire system impairment. This form must be visible when the fire system is impaired.

### IMPAIRMENT IDENTIFICATION:

<table>
<thead>
<tr>
<th>Hennepin County Building Name:</th>
<th>Date / Time Impairment to Begin and End (one day maximum – new permit required daily):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location where work will be performed (Floor/Room#):</td>
<td>Contractor Company Name:</td>
</tr>
<tr>
<td>Hennepin County Permit Authorizing Individual Name</td>
<td>Supervisor Name:</td>
</tr>
<tr>
<td>HC Authorizing Individual Phone Number:</td>
<td>Supervisor Phone Number:</td>
</tr>
<tr>
<td>HC Authorizing Individual Signature/Date:</td>
<td>Supervisor Signature/Date:</td>
</tr>
</tbody>
</table>

### Prior to Impairment:

Be ready to provide the following information to AIG: your name, your company name, telephone number, type of impairment, partial or full impairment, estimated length of impairment, precautions to be taken during impairment.

- [ ] Notify SOC 612-348-5111
- [ ] Notify Fire Department
- [ ] Notify AIG 1-877-705-7287

### IMPAIRMENT PERMIT SPECIFICATIONS:

Description of Impairment (be specific):

- [ ] Automatic Sprinkler System
- [ ] Fire Pump
- [ ] Underground Main
- [ ] Suction/Gravity Tank
- [ ] Detection System
- [ ] Alarm System
- [ ] Fixed System (CO2, Halon, FM 200, Dry)
- [ ] Other ____________________

### Restoration:

- [ ] Remove permit form
- [ ] Open all valves
- [ ] Conduct a drain test
- [ ] Place all system devices back in service

- [ ] Notify SOC 612-348-5111
- [ ] Notify Fire Department
- [ ] Notify AIG 1-877-705-7287

**POST THIS PERMIT AT IMPAIRMENT LOCATION**

Fax copy of completed form to Hennepin County Workplace Safety at 612-348-3492

(Revised 08/2018)
## Entry Permit Form (1 of 2)

### Permit date:

<table>
<thead>
<tr>
<th>Work shift</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
</tr>
</thead>
</table>

### Expires:

<p>| | |</p>
<table>
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</table>

### Time started:

### Permit space to be entered (name and location of space):

### Purpose of entry:

- **Names of trained, authorized individuals**
  - Entry supervisor:
  - Entry attendant:
  - Authorized entrants:
  - Authorized entrants:

### Emergency contact information

- Emergency responder:
- Phone number:
- Contact person:
  - Time:

### Pre-entry requirements

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
<th>Requirements</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lockout - tagout/de-energize</td>
<td></td>
<td></td>
<td></td>
<td>Hot work permit</td>
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<td></td>
</tr>
<tr>
<td>Pipes(s) broken or capped or blanked</td>
<td></td>
<td></td>
<td></td>
<td>Fall arrest harness/lifeline/tripod</td>
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<tr>
<td>Purge or flush or drain</td>
<td></td>
<td></td>
<td></td>
<td>Personal protective equipment</td>
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<tr>
<td>Ventilation (natural or mechanical)</td>
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<td></td>
<td></td>
<td>Hardhat</td>
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<tr>
<td>Secure area</td>
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<td></td>
<td></td>
<td>Gloves</td>
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<tr>
<td>Safe lighting</td>
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<td></td>
<td>Safety glasses</td>
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<tr>
<td>Non-sparking tools</td>
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<td></td>
<td></td>
<td>Respirator, type</td>
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<tr>
<td>Communication method</td>
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<td>Other PPE:</td>
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<tr>
<td>Contractor employees involved</td>
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<td>Other PPE:</td>
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</tbody>
</table>

### Space-monitoring results

<table>
<thead>
<tr>
<th>Monitor at least every four hours</th>
<th>Permissible entry levels</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time: Initial:</td>
<td>Time: Initial:</td>
<td>Time:</td>
<td>Time:</td>
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</tr>
</tbody>
</table>

- Percent oxygen: 19.5% to 23.5%
- Combustible gas: Less than 10% LEL
- Other toxic gas
- Other toxic gas
- Other toxic gas
<table>
<thead>
<tr>
<th>Possible atmospheric hazards</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of oxygen</td>
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<tr>
<td>Combustible gases</td>
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<tr>
<td>Combustible vapors</td>
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<td>Combustible dusts</td>
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<tr>
<td>Toxic gases/vapors</td>
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<td>Possible non-atmospheric hazards</td>
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<td>Noise</td>
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<td>Chemical contact</td>
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<td>Electrical hazard</td>
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<td>Mechanical exposure</td>
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<td>Temperature extreme</td>
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<td>Entrapment</td>
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<tr>
<td>Other non-atmospheric hazard</td>
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</table>

**Pre-entry checklist**

**Do not enter this permit space until the following “needs action” conditions are corrected.**

**OK**  **Needs action**

- Before entering the permit space, the entry supervisor or designee must notify the rescue team. IDLH conditions require at least one rescue team member located outside the space.
- A minimum of two employees must be assigned to work involving permit space entry. One employee must remain outside the permit space at all times.
- The surrounding area must be surveyed to show that it is free of hazards such as drifting vapors from tanks, piping, sewers, or vehicle exhaust.
- Those responsible for operation of the gas monitor have been trained.
- Gas monitor calibration tests and functional test (fresh air calibration) have been performed this shift on the gas monitor. If so, by whom? _____
- The atmosphere will be continuously monitored while the space is occupied, if required by entry procedure.

**This permit has been terminated for the following reason:**

- Work completed  Canceled  Time:  Note:

| Entry Supervisor’s signature | Time: | Date: / / |
**Alternate Entry Procedure/Reclassification**

**Section A: Alternate entry procedure**

Section A may be used instead of the entry permit if all of the following conditions are **Yes**:  

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>The only hazard is atmospheric.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous forced-air ventilation <strong>alone</strong> is sufficient to keep the space safe for entry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring and inspection show that other hazardous conditions do not exist.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditions that make it unsafe to remove entrance cover have been eliminated.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Openings are guarded to protect employees from falls and falling objects.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** When permit-space entry is required to verify conditions, the PRCS program and entry permit must be used. Use the table below to document test results for safe entry.

<table>
<thead>
<tr>
<th>Supporting documentation for safe entry</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of oxygen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustible gas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other toxic gas</td>
<td></td>
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<tr>
<td>Other toxic gas</td>
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<td></td>
</tr>
<tr>
<td>Other toxic gas</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Section B: Reclassification of a permit space to a non-permit space**

Section B may be used instead of the entry permit if all of the following conditions are **Yes**:  

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>The permit space poses no actual or potential atmospheric hazards.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All hazards within the space can be eliminated without entry into the space.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employees have been informed or shown the actions taken to eliminate hazards.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** When permit-space entry is required to verify conditions, the permit-space program and entry permit must be used.

- [ ] Alternate entry  
- [ ] Reclassification  

Space location:_________________________  
Space description:_________________________  
Name of person making the determination:_________________________
PART 1: GENERAL

1.01 RELATED DOCUMENTS

A. The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

B. Refer to other Project Documentation for additional security measures required for the Work, not limited to agreements arising from the Best Value procurement process and instructions given from the Owner regarding access to, and work and behavior within occupied Hennepin County land and facilities.

1.02 SUMMARY

A. Before allowing any direct or indirect employees to perform Work of the Contract, the Contractor shall procure criminal background security checks on all employees. Contractor personnel and all subcontractor personnel entering County property must submit to criminal background checks. Contractor is to allow a minimum of 7 calendar days for the researching agency to process and respond to the Contractor’s requests. Contractor shall receive the information reported from the researching agency, arrange for said information to be shared with the Owner, and receive additional information as may be provided by the Owner regarding suitability for the Work.

B. The Contractor will direct work assignments and/or make changes to assignments, or restrict an employee from Owner’s land or occupied spaces based on the nature of the above report information. The costs of Contractor’s employee reassignment(s) or Work denial(s) based on results of criminal background check information shall be borne exclusively by the Contractor.

C. The Owner does not control the count of Contractor employees necessary to complete the Work. The Contractor shall provide a minimum allowance of sixty ($60.00) dollars per each employee undergoing a background check. The Owner is not familiar with the demeanor and history of each of the Contractor employees and where the researching agency must charge additional time and/or dollars for employees requiring expanded research, such additions are a business risk controlled by the Contractor and will be borne solely by the Contractor in accordance with Article 10.2 of the General Conditions of the Contract for Construction.

D. Employees and personnel that do not have a County FSSD approved security background check will not be allowed onto the Project site.

1.03 SUBMITTALS

A. Prior to start of any Work upon the Project, the Contractor shall furnish the Owner with a complete list of employees indicating the date on which the Owner found each employee’s criminal background acceptable.

B. The Contractor will update this personnel list, within five (5) business days of any change in personnel for the duration of this agreement. The Contractor shall maintain, update and resubmit the complete list monthly or more often as added labor needs may demand. Interim investigative report sharing will be required, independent of this maintained complete list. All processing and information sharing requirements of this section are to be accomplished on a time of the essence basis.

C. The complete list shall include the date of each employee’s information submittal to the researching agency, the date of the agency’s reply, and the receipt date of the Owner’s comments.

PART 2: PRODUCTS – Not Applicable.
PART 3: EXECUTION

A. Contractor shall reproduce and distribute to all employees to the Work the Facility Services Security Division (FSSD) criminal background investigation form(s) and legal release(s) necessary to perform identity and criminal background checks, as are attached at the end of this section. Review the attached Instructions for Use page prior to form distribution.

B. Delivery truck and car drivers who do not park within 50 feet of the building and do not physically enter the building will not need a background check.

C. The Contractor shall have each employee provide the requested information required for a criminal background check and release of personal data. Prior to completing each investigation form, the Contractor shall positively identify the employee’s name, previous names, or aliases, and date of birth through an official record such as a driver’s license, state identification card or certified birth certificate.

D. Payments to research agency(ies) must be per individual applicant and can not be grouped with other applications.

E. Except where forms indicate “Office Use Only”, forms must be fully complete and bear the employee’s signature and date of application. Incomplete forms and forms received with a signed date older than 5 calendar days will be rejected by the research agency.

F. It is the responsibility of the Contractor to establish a single, privately controlled e-mail address for communications with, and receipt of investigative reports from, the research agency.

G. It is the responsibility of the Contractor to separately establish a single, privately controlled e-mail address for receipt of Owner reports from the FSSD.

H. The Contractor will be notified by the research agency, through their online address, of the results of employee criminal background checks. Contractor shall review the detailed results of the background checks as required by the Contract, and make a determination regarding suitability of the employee’s work assignments upon the Owner’s property prior to an employee’s start of Work. The Contractor shall share the investigative results with the Owner, which shall include the Contractor’s written determination of the applicant’s Work suitability.

I. Contractor shall consider making personnel work assignment changes where Owner’s reply information requests further review or re-consideration of suitability factors.

J. A two page instruction sheet and a personal identification and release form for background checks follows this page. The Owner reserves the right to revise the attached forms in order to respond to changing processes by the researching agency(ies).

K. All forms shall be fully completed and forwarded in a timely manner. Work delay caused by the Contractor’s or its employees’ failure to deliver the forms in a timely manner will not entitle the Contractor to an increase in the Contract Sum or an extension of the Contract Time.

END OF SECTION
Background Breakdown

Security will accept for photo id a background from:

Any of the below OR *established background for employment by vendor (Cintas, etc.) *see Mike Schlafer for approval process

All backgrounds below are valid for 3 years- subject to removal/rejection by department performing background.

**HCSO/DOCCR Basic/Level 1 Escorted Background**

Contact respective department for submittal and results. These are intended for use in their buildings only.

- Criminal History systems check
- DVS check
- DHS required for County Home School
- PREA inform and training

**HCSO/DOCCR Advanced/Level 2 Unescorted Background**

Contact respective department for submittal and results. These are intended for use in their buildings only.

- Fingerprints required (BCA Check) – note: this averages 4 weeks for return (sometimes up to 8)
- Criminal History systems check
- DVS check
- DHS required for County Home School
- PREA inform and training

**McDowell Agency Background**

Used primarily for Government Center access and/or required for vendors with a written caveat in their contract. Must have a valid authorization form for Security to retrieve results.

- Criminal record check – based upon subject entry
- Sex Offender Registry check
- Social Security Trace

**Contacts**

**Facility Services**
Mandy Wienke or Kathy Isberg
Backgrounds and Photo ID
Office: 612-543-3562
Photo ID: 612-348-7580
ps.card.access@hennepin.us

**Facilities Management**
Vendor Access
ps.contractoraccessrequests@hennepin.us

**HCSO**
Angela McGregor
Professional Standards/Backgrounds
Angela Office: 612-348-6372
angela.mcgregor@hennepin.us

**DOCCR**
Contact based on location:
ACF – Erica Johnson
JDC – Michelle Velasco
CHS – LeeAnn Hicks
CCR – Dan Bronk
Probation – Jennifer Belde
OAS – Mindy Strese
Contractor/Vendor Background Instructions

In accordance with your contract, you are required to submit a criminal background for employees assigned to our facilities. Please follow the steps – in order – below to be backgrounded and granted access to our facilities.

Please allow for 10 business days to complete all steps in this process.

If you have been backgrounded by the Hennepin County Department of Community Corrections and Rehabilitation (DOCCR) or the Hennepin County Sheriff’s Office (HCSO), it is not necessary to complete a Facility Services Background Form. Please provide this information to your contact for verification and continue to Step 3.

1. McDowell Agency

It is the vendor’s responsibility to establish an account with Hennepin County’s approved employment screening agency. You may obtain the necessary forms to set-up an account with the McDowell Agency outlined below:

Contact McDowell directly at 651-644-3880 or www.mcdowellagency.com
1. Select Contact Us
2. Complete the fields listed under the “to request more information” section of the page
3. Once you submit the information the forms will then be sent to you

Once an account is established, each employee who will be assigned to the contract with Hennepin County will be required to complete a screening through the above company.

2. Hennepin County Request Form

In addition to the McDowell background check, you will be required to submit a “Facility Services Contractor Background Request Form” for each employee – this form can be found at the bottom of this document. This form allows authorized Hennepin County representatives to receive information from McDowell.

The Facility Services Contractor Background Request Form can be submitted to Hennepin County in one of the following ways:
These forms must be processed by the Security Division prior to the first day the employee is assigned to the contract. Please allow a minimum of 5 business days to process background requests.

Once your background is processed and your representative receives an email from Hennepin County of approval, please proceed to step 3.

3. Access Request

In order to receive a Hennepin County photo ID card, the vendor’s representative should submit the project being worked and name(s) of persons needing access to ps.contractoraccessrequests@hennepin.us - the Facility Services Vendor Card Access Contact will determine the access required for your company/project and submit this request to Photo ID. This may take up to 5 business days to process.

Once you’ve received confirmation of completion, please proceed to step 4.

4. Photo ID

The Hennepin County ID card will require a photo, and will be issued only after the contract requirements regarding background checks have been fulfilled and access is requested. The vendor’s representative should contact our Photo ID office at 612-348-7580 to obtain open hours or schedule an appointment.

* In the event a vendor’s employee is found to be unsuitable for assignment to a Hennepin County contract, it is the responsibility of the vendor or their representative to communicate this with their employee. Unless otherwise arranged, at no time should the vendor's employee be directed to contact the Security Division directly. Due to data privacy, the Security Division will not provide detail of their findings without written consent from the vendor's employee.
FACILITY SERVICES – CONTRACTOR CRIMINAL BACKGROUND REQUEST

PLEASE PRINT (Illegible information will be returned – please provide full legal name as it appears on state issued ID)

Print FULL Name:_____________________________________________________________________________________

First Middle Last

Other Names Used (alias, maiden name, etc.):_______________________________________________________

Date of Birth:____________________________________________

I authorize Hennepin County Facility Services Department – Security Division to conduct a criminal background check for the purpose of contracted employment in the county facilities and/or on county property.

Note: failure to provide this authorization will prevent the Security Division from completing the required checks and will result in your inability to work in county facilities.

__________________________________________________________________________________________

Signature Date

Company Name:_____________________________________________________________________________________

Representative Name:_____________________________________________ Phone:__________________________

Email Address:_______________________________________________________________________________________

If sub-contractor – name of company submitting background: ____________________________________

Project requiring access: __________________________________________________________________________________

– A background check was conducted on this candidate using The McDowell Agency, Inc. (see instructions for clarification- HCSO/DOCCR backgrounds do not require this form)

* In order to complete this request, Hennepin County Facility Services Security must be furnished with copies of the above information or access to view the results online (see step 1 of instructions).

– This form must be received by the Hennepin County Facility Services Department Security Division prior to the employee being scheduled for the project and/or request for identification card, access card, or facility keys.

– Backgrounds and Access Cards are valid for 3 years, subject to revocation.

Security Division

Based on the information received and reviewed, this person ☐ IS / ☐ IS NOT an acceptable candidate for contract employment with Hennepin County.

__________________________________________________________________________________________

Facility Services Representative Date

Revised 2/2018-NLW
**ATTACHMENT A**
**PRIME CONTRACTOR RESPONSE**

**RESPONSIBLE CONTRACTOR VERIFICATION AND CERTIFICATION OF COMPLIANCE**

**PROJECT TITLE:**

This form includes changes by statutory references from the Laws of Minnesota 2015, chapter 64, sections 1-9. This form **must** be submitted with the response to this solicitation. A response received without this form, will be rejected.

Minn. Stat. § 16C.285, Subd. 7. **IMPLEMENTATION.** … any prime contractor or subcontractor or motor carrier that does not meet the minimum criteria in subdivision 3 or fails to verify that it meets those criteria is not a responsible contractor and is not eligible to be awarded a construction contract for the project or to perform work on the project…

Minn. Stat. § 16C.285, Subd. 3. **RESPONSIBLE CONTRACTOR, MINIMUM CRITERIA.** "Responsible contractor" means a contractor that conforms to the responsibility requirements in the solicitation document for its portion of the work on the project and verifies that it meets the following minimum criteria:

<table>
<thead>
<tr>
<th>(1)</th>
<th>The Contractor:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>is in compliance with workers' compensation and unemployment insurance requirements;</td>
</tr>
<tr>
<td>(ii)</td>
<td>is in compliance with Department of Revenue and Department of Employment and Economic Development registration requirements if it has employees;</td>
</tr>
<tr>
<td>(iii)</td>
<td>has a valid federal tax identification number or a valid Social Security number if an individual; and</td>
</tr>
<tr>
<td>(iv)</td>
<td>has filed a certificate of authority to transact business in Minnesota with the Secretary of State if a foreign corporation or cooperative.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(2)</th>
<th>The contractor or related entity is in compliance with and, during the three-year period before submitting the verification, has not violated section 177.24, 177.25, 177.41 to 177.44, 181.13, 181.14, or 181.722, and has not violated United States Code, title 29, sections 201 to 219, or United States Code, title 40, sections 3141 to 3148. For purposes of this clause, a violation occurs when a contractor or related entity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>repeatedly fails to pay statutorily required wages or penalties on one or more separate projects for a total underpayment of $25,000 or more within the three-year period, provided that a failure to pay is &quot;repeated&quot; only if it involves two or more separate and distinct occurrences of underpayment during the three-year period;</td>
</tr>
<tr>
<td>(ii)</td>
<td>has been issued an order to comply by the commissioner of Labor and Industry that has become final;</td>
</tr>
<tr>
<td>(iii)</td>
<td>has been issued at least two determination letters within the three-year period by the Department of Transportation finding an underpayment by the contractor or related entity to its own employees;</td>
</tr>
<tr>
<td>(iv)</td>
<td>has been found by the commissioner of Labor and Industry to have repeatedly or willfully violated any of the sections referenced in this clause pursuant to section 177.27;</td>
</tr>
<tr>
<td>(v)</td>
<td>has been issued a ruling or findings of underpayment by the administrator of the Wage and Hour Division of the United States Department of Labor that have become final or have been upheld by an administrative law judge or the Administrative Review Board; or</td>
</tr>
<tr>
<td>(vi)</td>
<td>has been found liable for underpayment of wages or penalties or misrepresenting a construction worker as an independent contractor in an action brought in a court having jurisdiction. Provided that, if the contractor or related entity contests a determination of underpayment by the Department of Transportation in a contested case proceeding, a violation does not occur until the contested case proceeding has concluded with a determination that the contractor or related entity underpaid wages or penalties;*</td>
</tr>
<tr>
<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>(3)</td>
<td>The contractor or related entity is in compliance with and, during the three-year period before submitting the verification, has not violated section 181.723 or chapter 326B. For purposes of this clause, a violation occurs when a contractor or related entity has been issued a final administrative or licensing order;*</td>
</tr>
<tr>
<td>(4)</td>
<td>The contractor or related entity has not, more than twice during the three-year period before submitting the verification, had a certificate of compliance under section 363A.36 revoked or suspended based on the provisions of section 363A.36, with the revocation or suspension becoming final because it was upheld by the Office of Administrative Hearings or was not appealed to the office;*</td>
</tr>
<tr>
<td>(5)</td>
<td>The contractor or related entity has not received a final determination assessing a monetary sanction from the Department of Administration or Transportation for failure to meet targeted group business, disadvantaged business enterprise, or veteran-owned business goals, due to a lack of good faith effort, more than once during the three-year period before submitting the verification;*</td>
</tr>
<tr>
<td></td>
<td>* Any violations, suspensions, revocations, or sanctions, as defined in clauses (2) to (5), occurring prior to July 1, 2014, shall not be considered in determining whether a contractor or related entity meets the minimum criteria.</td>
</tr>
<tr>
<td>(6)</td>
<td>The contractor or related entity is not currently suspended or debarred by the federal government or the state of Minnesota or any of its departments, commissions, agencies, or political subdivisions that have authority to debar a contractor; and</td>
</tr>
<tr>
<td>(7)</td>
<td>All subcontractors and motor carriers that the contractor intends to use to perform project work have verified to the contractor through a signed statement under oath by an owner or officer that they meet the minimum criteria listed in clauses (1) to (6).</td>
</tr>
</tbody>
</table>

**Minn. Stat. § 16C.285, Subd. 5. SUBCONTRACTOR VERIFICATION.**

A prime contractor or subcontractor shall include in its verification of compliance under subdivision 4 a list of all of its first-tier subcontractors that it intends to retain for work on the project. Prior to execution of a construction contract, and as a condition precedent to the execution of a construction contract, the apparent successful prime contractor shall submit to the contracting authority a supplemental verification under oath confirming compliance with subdivision 3, clause (7). Each contractor or subcontractor shall obtain from all subcontractors with which it will have a direct contractual relationship a signed statement under oath by an owner or officer verifying that they meet all of the minimum criteria in subdivision 3 prior to execution of a construction contract with each subcontractor.

If a prime contractor or any subcontractor retains additional subcontractors on the project after submitting its verification of compliance, the prime contractor or subcontractor shall obtain verifications of compliance from each additional subcontractor with which it has a direct contractual relationship and shall submit a supplemental verification confirming compliance with subdivision 3, clause (7), within 14 days of retaining the additional subcontractors.

A prime contractor shall submit to the contracting authority upon request copies of the signed verifications of compliance from all subcontractors of any tier pursuant to subdivision 3, clause (7). A prime contractor and subcontractors shall not be responsible for the false statements of any subcontractor with which they do not have a direct contractual relationship. A prime contractor and subcontractors shall be responsible for false statements by their first-tier subcontractors with which they have a direct contractual relationship only if they accept the verification of compliance with actual knowledge that it contains a false statement.

Subd. 5a. **Motor carrier verification.** A prime contractor or subcontractor shall obtain annually from all motor carriers with which it will have a direct contractual relationship a signed statement under oath by an owner or officer verifying that they meet all of the minimum criteria in subdivision 3 prior to execution of a construction contract with each motor carrier. A prime contractor or subcontractor shall require each such motor carrier to provide it with immediate written notification in the event that the motor carrier no longer meets one or more of the minimum criteria in subdivision 3 after submitting its annual verification. A motor carrier shall be ineligible to perform work on a project covered by this section if it does not meet all the minimum criteria in subdivision 3. Upon request, a prime contractor or subcontractor shall submit to the contracting authority the signed verifications of compliance from all motor carriers providing for-hire transportation of materials, equipment, or supplies for a project.
Minn. Stat. § 16C.285, Subd. 4. **VERIFICATION OF COMPLIANCE.**

A contractor responding to a solicitation document of a contracting authority shall submit to the contracting authority a signed statement under oath by an owner or officer verifying compliance with each of the minimum criteria in subdivision 3, with the exception of clause (7), at the time that it responds to the solicitation document.

A contracting authority may accept a signed statement under oath as sufficient to demonstrate that a contractor is a responsible contractor and shall not be held liable for awarding a contract in reasonable reliance on that statement. A prime contractor, subcontractor, or motor carrier that fails to verify compliance with any one of the required minimum criteria or makes a false statement under oath in a verification of compliance shall be ineligible to be awarded a construction contract on the project for which the verification was submitted.

A false statement under oath verifying compliance with any of the minimum criteria may result in termination of a construction contract that has already been awarded to a prime contractor or subcontractor or motor carrier that submits a false statement. A contracting authority shall not be liable for declining to award a contract or terminating a contract based on a reasonable determination that the contractor failed to verify compliance with the minimum criteria or falsely stated that it meets the minimum criteria. A verification of compliance need not be notarized. An electronic verification of compliance made and submitted as part of an electronic bid shall be an acceptable verification of compliance under this section provided that it contains an electronic signature as defined in section 325L.02, paragraph (h).

**CERTIFICATION**

By signing this document I certify that I am an owner or officer of the company, and I swear under oath that:

1) My company meets each of the Minimum Criteria to be a responsible contractor as defined herein and is in compliance with Minn. Stat. § 16C.285,

2) If my company is awarded a contract, I will submit Attachment A-1 prior to contract execution, and

3) if my company is awarded a contract, I will also submit Attachment A-2 as required.

Authorized Signature of Owner or Officer:  
Printed Name:

Title:  
Date:

Company Name:

NOTE: Minn. Stat. § 16C.285, Subd. 2, (c) If only one prime contractor responds to a solicitation document, a contracting authority may award a construction contract to the responding prime contractor even if the minimum criteria in subdivision 3 are not met.
Minn. Stat. § 16C.285, Subd. 5. A prime contractor or subcontractor shall include in its verification of compliance under subdivision 4 a list of all of its first-tier subcontractors that it intends to retain for work on the project. Prior to execution of a construction contract, and as a condition precedent to the execution of a construction contract, the apparent successful prime contractor shall submit to the contracting authority a supplemental verification under oath confirming compliance with subdivision 3, clause (7). Each contractor or subcontractor shall obtain from all subcontractors with which it will have a direct contractual relationship a signed statement under oath by an owner or officer verifying that they meet all of the minimum criteria in subdivision 3 prior to execution of a construction contract with each subcontractor.

**FIRST TIER SUBCONTRACTOR NAMES**

<table>
<thead>
<tr>
<th>FIRST TIER SUBCONTRACTOR NAMES* (Legal name of company as registered with the Secretary of State)</th>
<th>Name of city where company home office is located</th>
</tr>
</thead>
<tbody>
<tr>
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*Attach additional sheets as needed for submission of all first-tier subcontractors.

**SUPPLEMENTAL CERTIFICATION FOR ATTACHMENT A-1**

By signing this document I certify that I am an owner or officer of the company, and I swear under oath that:

All first-tier subcontractors listed on attachment A-1 have verified through a signed statement under oath by an owner or officer that they meet the minimum criteria to be a responsible contractor as defined in Minn. Stat. § 16C.285.

<table>
<thead>
<tr>
<th>Authorized Signature of Owner or Officer:</th>
<th>Printed Name:</th>
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<thead>
<tr>
<th>Title:</th>
<th>Date:</th>
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<table>
<thead>
<tr>
<th>Company Name:</th>
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ATTACHMENT A-2

ADDITIONAL SUBCONTRACTORS LIST

PRIME CONTRACTOR TO SUBMIT AS SUBCONTRACTORS ARE ADDED TO THE PROJECT

PROJECT TITLE: _________________________________________________________________

This form must be submitted to the Project Manager or individual as identified in the solicitation document.

Minn. Stat. § 16C.285, Subd. 5. … If a prime contractor or any subcontractor retains additional subcontractors on the project after submitting its verification of compliance, the prime contractor or subcontractor shall obtain verifications of compliance from each additional subcontractor with which it has a direct contractual relationship and shall submit a supplemental verification confirming compliance with subdivision 3, clause (7), within 14 days of retaining the additional subcontractors. …

<table>
<thead>
<tr>
<th>ADDITIONAL SUBCONTRACTOR NAMES</th>
<th>Name of city where company home office is located</th>
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<tbody>
<tr>
<td>(Legal name of company as registered with the Secretary of State)</td>
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*Attach additional sheets as needed for submission of all additional subcontractors.

SUPPLEMENTAL CERTIFICATION FOR ATTACHMENT A-2

By signing this document I certify that I am an owner or officer of the company, and I swear under oath that:

All additional subcontractors listed on Attachment A-2 have verified through a signed statement under oath by an owner or officer that they meet the minimum criteria to be a responsible contractor as defined in Minn. Stat. § 16C.285.

<table>
<thead>
<tr>
<th>Authorized Signature of Owner or Officer:</th>
<th>Printed Name:</th>
</tr>
</thead>
<tbody>
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<table>
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| Company Name: | |
|---------------|
Construction Type: Commercial

County Number: 27

County Name: HENNEPIN

Effective: 2018-12-17    Revised: 2019-01-28

This project is covered by Minnesota prevailing wage statutes. Wage rates listed below are the minimum hourly rates to be paid on this project.

All hours worked in excess of eight (8) hours per day or forty (40) hours per week shall be paid at a rate of one and one half (1 1/2) times the basic hourly rate.

Violations should be reported to:

Department of Labor and Industry
Prevailing Wage Section
443 Lafayette Road N
St Paul, MN 55155
(651) 284-5091
DLI.PrevWage@state.mn.us

* Indicates that adjacent county rates were used for the labor class listed.

County: HENNEPIN (27)

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<tr>
<th>LABOR CODE AND CLASS</th>
<th>EFFECT DATE</th>
<th>BASIC RATE</th>
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<td>LABORERS (101 - 112)</td>
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<td>(SPECIAL CRAFTS 701 - 730)</td>
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**SPECIAL EQUIPMENT (201 - 204)**

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<td>BOOM TRUCK</td>
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203  LANDSCAPING EQUIPMENT, INCLUDES HYDRO
SEEDER OR MULCHER, SOD ROLLER, FARM TRACTOR
WITH ATTACHMENT SPECIFICALLY SEEDING,
SODDING, OR PLANT, AND TWO-FRAMED FORKLIFT
(EXCLUDING FRONT, POSIT-TRACK, AND SKID STEER
LOADERS), NO EARTHWORK OR GRADING FOR
ELEVATIONS

2018-12-17  23.02  15.99  39.01
2019-05-01  24.00  16.96  40.96

204*  OFF-ROAD TRUCK

2018-12-17  37.83  18.65  56.48

205  PAVEMENT MARKING OR MARKING REMOVAL
EQUIPMENT (ONE OR TWO PERSON OPERATORS);
SELF-PROPELLED TRUCK OR TRAILER MOUNTED
UNITS.

2018-12-17  37.05  19.39  56.44

HIGHWAY/HEAVY POWER EQUIPMENT OPERATOR

GROUP 2

306  GRADER OR MOTOR PATROL

308  TUGBOAT 100 H.P. AND OVER WHEN LICENSE REQUIRED (HIGHWAY AND HEAVY ONLY)

GROUP 3 *

2018-12-17  36.34  20.30  56.64
2019-05-01  38.09  20.50  58.59

309  ASPHALT BITUMINOUS STABILIZER PLANT

310  CABLEWAY

312  DERRICK (GUY OR STIFFLEG)(POWER)(SKIDS OR STATIONARY) (HIGHWAY AND HEAVY
ONLY)

314  DREDGE OR ENGINEERS, DREDGE (POWER) AND ENGINEER

316  LOCOMOTIVE CRANE OPERATOR

320  TANDEM SCRAPER

322  TUGBOAT 100 H.P AND OVER (HIGHWAY AND HEAVY ONLY)

GROUP 4

2018-12-17  36.04  20.30  56.34
2019-05-01  37.79  20.50  58.29

323  AIR TRACK ROCK DRILL

324  AUTOMATIC ROAD MACHINE (CMI OR SIMILAR) (HIGHWAY AND HEAVY ONLY)
BACKFILLER OPERATOR

BITUMINOUS ROLLERS, RUBBER TIRED OR STEEL DRUMMED (EIGHT TONS AND OVER)

BITUMINOUS SPREADER AND FINISHING MACHINES (POWER), INCLUDING PAVERS, MACRO SURFACING AND MICRO SURFACING, OR SIMILAR TYPES (OPERATOR AND SCREED PERSON)

BROKK OR R.T.C. REMOTE CONTROL OR SIMILAR TYPE WITH ALL ATTACHMENTS

CAT CHALLENGER TRACTORS OR SIMILAR TYPES PULLING ROCK WAGONS, BULLDOZERS AND SCRAPERS

CHIP HARVESTER AND TREE CUTTER

CONCRETE DISTRIBUTOR AND SPREADER FINISHING MACHINE, LONGITUDINAL FLOAT, JOINT MACHINE, AND SPRAY MACHINE

CONCRETE MOBIL (HIGHWAY AND HEAVY ONLY)

CRUSHING PLANT (GRAVEL AND STONE) OR GRAVEL WASHING, CRUSHING AND SCREENING PLANT

CURB MACHINE

DIRECTIONAL BORING MACHINE

DOPE MACHINE (PIPELINE)

DUAL TRACTOR

ELEVATING GRADER

GPS REMOTE OPERATING OF EQUIPMENT

HYDRAULIC TREE PLANTER

LAUNCHER PERSON (TANKER PERSON OR PILOT LICENSE)

LOCOMOTIVE (HIGHWAY AND HEAVY ONLY)

MILLING, GRINDING, PLANNING, FINE GRADE, OR TRIMMER MACHINE

PAVEMENT BREAKER OR TAMPERING MACHINE (POWER DRIVEN) MIGHTY MITE OR SIMILAR TYPE

PIPELINE WRAPPING, CLEANING OR BENDING MACHINE

POWER ACTUATED HORIZONTAL BORING MACHINE, OVER SIX INCHES

PUGMILL

RUBBER-TIRED FARM TRACTOR WITH BACKHOE INCLUDING ATTACHMENTS (HIGHWAY AND HEAVY ONLY)

SCRAPER

SELF-PROPELLED SOIL STABILIZER

SLIP FORM (POWER DRIVEN) (PAVING)

TIE TAMPER AND BALLAST MACHINE

TRACTOR, WHEEL TYPE, OVER 50 H.P. WITH PTO UNRELATED TO LANDSCAPING (HIGHWAY AND HEAVY ONLY)

TUB GRINDER, MORBARK, OR SIMILAR TYPE
GROUP 5

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<td>370</td>
<td>BITUMINOUS ROLLER (UNDER EIGHT TONS)</td>
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<td>371</td>
<td>CONCRETE SAW (MULTIPLE BLADE) (POWER OPERATED)</td>
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<td>372</td>
<td>FORM TRENCH DIGGER (POWER)</td>
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<tr>
<td>375</td>
<td>HYDRAULIC LOG SPLITTER</td>
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<tr>
<td>376</td>
<td>LOADER (BARBER GREENE OR SIMILAR TYPE)</td>
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<tr>
<td>377</td>
<td>POST HOLE DRIVING MACHINE/POST HOLE AUGER</td>
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<tr>
<td>379</td>
<td>POWER ACTUATED JACK</td>
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<tr>
<td>381</td>
<td>SELF-PROPELLED CHIP SPREADER (FLAHERTY OR SIMILAR)</td>
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<tr>
<td>382</td>
<td>SHEEP FOOT COMPACTOR WITH BLADE . 200 H.P. AND OVER</td>
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<tr>
<td>383</td>
<td>SHOULDERING MACHINE (POWER) APSCO OR SIMILAR TYPE INCLUDING SELF-PROPELLED SAND AND CHIP SPREADER</td>
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<tr>
<td>384</td>
<td>STUMP CHIPPER AND TREE CHIPPER</td>
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<td>385</td>
<td>TREE FARMER (MACHINE)</td>
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GROUP 6 *

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<tr>
<td>387</td>
<td>CAT, CHALLENGER, OR SIMILAR TYPE OF TRACTORS, WHEN PULLING DISK OR ROLLER</td>
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<td>389</td>
<td>DREDGE DECK HAND</td>
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<tr>
<td>391</td>
<td>GRAVEL SCREENING PLANT (PORTABLE NOT CRUSHING OR WASHING)</td>
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<td>393</td>
<td>LEVER PERSON</td>
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<tr>
<td>395</td>
<td>POWER SWEEPER</td>
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<tr>
<td>396</td>
<td>SHEEP FOOT ROLLER AND ROLLERS ON GRAVEL COMPACTION, INCLUDING VIBRATING ROLLERS</td>
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<td>397</td>
<td>TRACTOR, WHEEL TYPE, OVER 50 H.P., UNRELATED TO LANDSCAPING</td>
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COMMERCIAL POWER EQUIPMENT OPERATOR

GROUP 1

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<tr>
<td>501</td>
<td>HELICOPTER PILOT (COMMERCIAL CONSTRUCTION ONLY)</td>
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<tr>
<td>502</td>
<td>TOWER CRANE 250 FEET AND OVER (COMMERCIAL CONSTRUCTION ONLY)</td>
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<tr>
<td>503</td>
<td>TRUCK CRAWLER CRANE WITH 200 FEET OF BOOM AND OVER, INCLUDING JIB (COMMERCIAL CONSTRUCTION ONLY)</td>
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GROUP 2

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<tr>
<td>504</td>
<td>CONCRETE PUMP WITH 50 METERS/164 FEET OF BOOM AND OVER (COMMERCIAL CONSTRUCTION ONLY)</td>
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<tr>
<td>505</td>
<td>PILE DRIVING WHEN THREE DRUMS IN USE (COMMERCIAL CONSTRUCTION ONLY)</td>
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TOWER CRANE 200 FEET AND OVER (COMMERCIAL CONSTRUCTION ONLY)
TRUCK OR CRAWLER CRANE WITH 150 FEET OF BOOM UP TO AND NOT INCLUDING 200 FEET, INCLUDING JIB (COMMERCIAL CONSTRUCTION ONLY)

GROUP 3
2018-12-17 39.39 20.30 59.69
ALL-TERRAIN VEHICLE CRANES (COMMERCIAL CONSTRUCTION ONLY)
CONCRETE PUMP 32-49 METERS/102-164 FEET (COMMERCIAL CONSTRUCTION ONLY)
DERRICK (GUY & STIFFLEG) (COMMERCIAL CONSTRUCTION ONLY)
STATIONARY TOWER CRANE UP TO 200 FEET
SELF-ERECTING TOWER CRANE 100 FEET AND OVER MEASURED FROM BOOM FOOT PIN (COMMERCIAL CONSTRUCTION ONLY)
TRAVELING TOWER CRANE (COMMERCIAL CONSTRUCTION ONLY)
TRUCK OR CRAWLER CRANE UP TO AND NOT INCLUDING 150 FEET OF BOOM, INCLUDING JIB (COMMERCIAL CONSTRUCTION ONLY)

GROUP 4
2018-12-17 39.05 20.30 59.35
CRAWLER BACKHOE INCLUDING ATTACHMENTS (COMMERCIAL CONSTRUCTION ONLY)
FIREPERSON, CHIEF BOILER LICENSE (COMMERCIAL CONSTRUCTION ONLY)
HOIST ENGINEER (THREE DRUMS OR MORE) (COMMERCIAL CONSTRUCTION ONLY)
LOCOMOTIVE (COMMERCIAL CONSTRUCTION ONLY)
OVERHEAD CRANE (INSIDE BUILDING PERIMETER) (COMMERCIAL CONSTRUCTION ONLY)
TRACTOR, BOOM TYPE (COMMERCIAL CONSTRUCTION ONLY)

GROUP 5
2018-12-17 38.13 20.30 58.43
AIR COMPRESSOR 450 CFM OR OVER (TWO OR MORE MACHINES) (COMMERCIAL CONSTRUCTION ONLY)
CONCRETE MIXER (COMMERCIAL CONSTRUCTION ONLY)
CONCRETE PUMP UP TO 31 METERS/101 FEET OF BOOM
DRILL RIGS, HEAVY ROTARY OR CHURN OR CABLE DRILL WHEN USED FOR CAISSON FOR ELEVATOR OR BUILDING CONSTRUCTION (COMMERCIAL CONSTRUCTION ONLY)
FORKLIFT (COMMERCIAL CONSTRUCTION ONLY)
FRONT END, SKID STEER 1 C YD AND OVER
HOIST ENGINEER (ONE OR TWO DRUMS) (COMMERCIAL CONSTRUCTION ONLY)
MECHANIC-WELDER (ON POWER EQUIPMENT) (COMMERCIAL CONSTRUCTION ONLY)
POWER PLANT (100 KW AND OVER OR MULTIPLES EQUAL TO 100KW AND OVER) (COMMERCIAL CONSTRUCTION ONLY)
PUMP OPERATOR AND/OR CONVEYOR (TWO OR MORE MACHINES) (COMMERCIAL CONSTRUCTION ONLY)
531 SELF-ERECTING TOWER CRANE UNDER 100 FEET MEASURED FROM BOOM FOOT PIN (COMMERCIAL CONSTRUCTION ONLY)
532 STRADDLE CARRIER (COMMERCIAL CONSTRUCTION ONLY)
533 TRACTOR OVER D2 (COMMERCIAL CONSTRUCTION ONLY)
534 WELL POINT PUMP (COMMERCIAL CONSTRUCTION ONLY)

GROUP 6

2018-12-17 36.62 20.30 56.92

535 CONCRETE BATCH PLANT (COMMERCIAL CONSTRUCTION ONLY)
536 FIREPERSON, FIRST CLASS BOILER LICENSE (COMMERCIAL CONSTRUCTION ONLY)
537 FRONT END, SKID STEER UP TO 1 C YD
538 GUNITE MACHINE (COMMERCIAL CONSTRUCTION ONLY)
539 TRACTOR OPERATOR D2 OR SIMILAR SIZE (COMMERCIAL CONSTRUCTION ONLY)
540 TRENCHING MACHINE (SEWER, WATER, GAS) EXCLUDES WALK BEHIND TRENCHER

GROUP 7

2018-12-17 35.50 20.30 55.80

541 AIR COMPRESSOR 600 CFM OR OVER (COMMERCIAL CONSTRUCTION ONLY)
542 BRAKEPERSON (COMMERCIAL CONSTRUCTION ONLY)
543 CONCRETE PUMP/PUMPCRETE OR COMPLACO TYPE (COMMERCIAL CONSTRUCTION ONLY)
544 FIREPERSON, TEMPORARY HEAT SECOND CLASS BOILER LICENSE (COMMERCIAL CONSTRUCTION ONLY)
545 OILER (POWER SHOVEL, CRANE, TRUCK CRANE, DRAGLINE, CRUSHERS AND MILLING MACHINES, OR OTHER SIMILAR POWER EQUIPMENT) (COMMERCIAL CONSTRUCTION ONLY)
546 PICK UP SWEEPER (ONE CUBIC YARD HOPPER CAPACITY) (COMMERCIAL CONSTRUCTION ONLY)
547 PUMP AND/OR CONVEYOR (COMMERCIAL CONSTRUCTION ONLY)

GROUP 8

2018-12-17 33.49 20.30 53.79

548 ELEVATOR OPERATOR (COMMERCIAL CONSTRUCTION ONLY)
549 GREASER (COMMERCIAL CONSTRUCTION ONLY)
550 MECHANICAL SPACE HEATER (TEMPORARY HEAT NO BOILER LICENSE REQUIRED) (COMMERCIAL CONSTRUCTION ONLY)

TRUCK DRIVERS

GROUP 1 *

2018-12-17 25.65 6.76 32.41

601 MECHANIC . WELDER
602 TRACTOR TRAILER DRIVER
603  TRUCK DRIVER (HAULING MACHINERY INCLUDING OPERATION OF HAND AND POWER OPERATED WINCHES)

**GROUP 2 * 2018-12-17 21.10 6.76 27.86**
604  FOUR OR MORE AXLE UNIT, STRAIGHT BODY TRUCK

**GROUP 3 * 2018-12-17 25.80 6.10 31.90**
605  BITUMINOUS DISTRIBUTOR DRIVER
606  BITUMINOUS DISTRIBUTOR (ONE PERSON OPERATION)
607  THREE AXLE UNITS

**GROUP 4 2018-12-17 35.82 8.18 44.00**
608  BITUMINOUS DISTRIBUTOR SPRAY OPERATOR (REAR AND OILER)
609  DUMP PERSON
610  GREASER
611  PILOT CAR DRIVER
612  RUBBER-TIRED, SELF-PROPELLED PACKER UNDER 8 TONS
613  TWO AXLE UNIT
614  SLURRY OPERATOR
615  TANK TRUCK HELPER (GAS, OIL, ROAD OIL, AND WATER)
616  TRACTOR OPERATOR, UNDER 50 H.P.

**SPECIAL CRAFTS**
607  TRACTOR OPERATOR, UNDER 50 H.P.

**SPECIAL CRAFTS**
701  HEATING AND FROST INSULATORS 2018-12-17 44.60 24.40 69.00
702  BOILERMAKERS 2018-12-17 37.22 27.14 64.36
703  BRICKLAYERS 2018-12-17 38.76 20.87 59.63
704  CARPENTERS 2018-12-17 37.18 21.45 58.63
705  CARPET LAYERS (LINOLEUM) 2018-12-17 37.84 19.19 57.03
706  CEMENT MASONS 2018-12-17 38.41 19.67 58.08
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SECTION 011100
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Project information.
   2. Work covered by Contract Documents.
   3. Work by Owner
   4. Access to site.
   5. Construction photographs.
   6. Work restrictions.

1.2 PROJECT INFORMATION

A. Project Identification:
   1. Project Location: North Regional Library 1315 Lowry Ave N, Minneapolis, MN 55411

B. Owner: Hennepin County Facility Services


1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. Work of Project is defined by Contract Documents and consists of the following:
   1. New Concrete curb and gutter at the lower north parking lot including lowering and repaving the parking lot. Concrete curb will be added to north edge of neighborhood alley. Also, waterproofing and insulation, granular backfill, and draintile to added to the east and south sides of the building, including adding of additional storm drain inlets,
   2. Landscape work to include improvements at the Lowry Avenue entrance, south main entrance breezeway, creation of a west children's garden and an east reading garden.
   3. Replacement of the roof system.
   4. Refurbishment of the exterior curtainwall system.
   5. Renovation of the interiors at the first and second floors creating flexible study and collaborative spaces for children, teens and adults.
   6. Modernization of the existing elevator and machine room.
   7. Improvement of acoustics at both levels of the library.
   8. Modification of the existing sprinkler system.
   9. Modification of the existing plumbing system.
  10. New HVAC equipment and ductwork.
  11. New LED lighting for both levels.
  12. Provide and install telecommunication cabling for Av and Security, provide and install the public address system, provide and install fire alarm system and entry systems, and provisions for new CCTV and entry control system. Security integration will be by the owner's vendor, but all other security work is under the contract. For data, Contractor does not plug the cables into the head end and user end equipment.

B. Type of Contract: Project will be constructed under a single prime contract.
C. Contractor to receive notice to proceed up to a month prior to start of construction. Start of construction is dependent on library move-out.

D. Art Removal: Hennepin County to assign KCI Conservation as a subcontractor to the Contractor for the removal, treatment, storage, return, and replacement of the existing artwork. The art move-out to occur prior to start of construction, concurrent with library move-out. Contractor to coordinate the work with Hennepin County and KCI Conservation. See Section 013516 Art Collections Preservation Project Procedures.

1.4 PROJECT MEETINGS

A. Pre-Construction Meeting: After award of Contract, at a time designated by Owner or Architect, Contractor and mechanical and electrical Subcontractors, shall attend a Pre-Construction Meeting. Procedures to be followed, critical Work sequencing, submittals, coordination efforts, Contract payments, and similar matters will be reviewed.

B. Progress Meetings: During construction, periodic site meetings will be held with Contractor, major Subcontractors, Owner, and Architect. These meetings will be held weekly (unless job conditions do not warrant) and may be held more frequently if job progress and needs indicate. Contractor and major Subcontractors shall have one or more responsible representatives in attendance. Contractor shall record "minutes" of meeting, shall distribute "minutes" as appropriate, and shall include such minutes within Project records.

1.5 WORK BY OWNER

A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate Work of this Contract with work performed by Owner.

1.6 ACCESS TO SITE

A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Tenant's right to perform work or to retain other contractors on portions of Project.

B. Use of Site: Limit use of Project site to areas within Contract limits indicated. Do not disturb portions of Project site beyond areas in which Work is indicated.

C. Utilities: Contractor to transfer utilities accounts (electrical service, water, storm, data, etc) from county to contractor at agreed start of construction.

D. Snow Removal: Contractor is responsible for snow removal within site limits. County will remove snow at sidewalks and driveway into Garage off of Girard.

E. Lawn Care: Contractor is responsible for mowing on site during construction.

1.7 USE OF BUILDING

A. Garage to be in use by Hennepin County. Contractor to coordinate any work required in/ around the garage with the owner. Contractor will have access to door/ vestibule at east side of garage, but no access to main garage space. Maintain Owner access to Girard (West) drive to garage.

B. Utilities: Contractor to transfer utilities accounts (electrical service, water, storm, data, etc) from county to contractor at agreed start of construction.

C. Boilers: While boilers are in operation, Contractor to coordinate with owner for boiler management. Owner will need to do daily checks. Any temperature adjustments shall be made by the owner. Contractor to communicate required modifications.
D. BAS: Contractor to Coordinate continued operation of BAS System with owner.

E. Elevator: Contractor is responsible for maintaining code required monthly maintenance of elevator while elevator is in operation. Contractor shall use county vendor, currently at a rate of $117.01. Contractor to maintain phone line in elevator and transfer account from Hennepin County to Contractor.

F. Fire Panel: Contractor to setup and pay for monitoring of fire protection during construction.

G. Keying: Contractor to install construction cores on doors to library during construction. Contractor to provide master key to owner.

1.8 SAFETY DIRECTOR

A. Provide safety supervision.

1.9 CONSTRUCTION PHOTOGRAPHS

A. Provide digital photos which are acceptable to the Owner, and taken at the following points of progress of the Work: Photos of roof installation, civil installation, parking lot subgrades, drain tile, etc., mechanical and electrical systems, interior finishing, at each date of Application for Payment, at Substantial Completion, and at Final Completion.

B. Provide appropriate views and adequate number of photographs to accurately depict the critical points of construction and the overall progress of the Work.

C. See also Section 01 32 33 Photographic Documentation.

1.10 WORK RESTRICTIONS

A. Entire Project site is designated an alcohol-free, tobacco-free, drug-free, and weapon-free zone. No smoking or other tobacco use, including cigarettes will be allowed on site by any person having anything to do with Project. Contractor to post signs and shall enforce this among personnel and Subcontractors.

PART 2 - PRODUCTS

NOT USED

PART 3 - PRODUCTS

NOT USED

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Add Alternates described in this Section are part of the Work only if enumerated in the Agreement.

2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other work of the Contract.

C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used) PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

Add Alternates

A. Add Alternate No. 1: Omit new roof and mansard on garage.

B. Add Alternate No. 1B: Add window film at West side of Bridge- Window film to be applied to all glazing on exterior face, including spandrel lites. See 3/A3.1. Film to be similar to 3M Safety & Security Window Film. If add alternate 1B is accepted, then 1A will be accepted.
C. Add Alternate No. 2: Add lobby millwork (6/A8.3) and custom material displays (qty 4, keynote 06 03).

D. Add Alternate No. 3: Add new wall acoustic panels, in lieu of leaving existing panels in place.

E. Add Alternate No. 4: Add inverter system for emergency light fixtures and eliminate battery backup in each light fixture on the inverter system.

F. Add Alternate No. 5: Add ship’s ladder connecting bridge roof to garage roof.

G. Add Alternate No. 6: Add conduit and handhole for future fiber connection.

H. Add Alternate No. 7: Add window film at East side of Bridge. Window film to be applied to all glazing on exterior face, including spandrel lites. See 3/A3.a. Film to be similar to 3M Safety & Security Window Film

H. Add Alternate No. 8: Add wood wall treatment at the stairs on both levels (4 walls total).

I. Add Alternate No. 9: In lieu of 2X@LED flat panel recessed light fixtures (Types A/A1, B/B1), provide and install 2x2 LED recessed volumetric troffer fixtures. (See Sheet E8.1)

J. Add Alternate No. 10: Provide Corian quartz toilet partitions, in lieu of plastic partitions.

K. Add Alternate No. 11: Shorten roof outriggers

L. Add Alternate No. 12: Replace basement mechanical room light fixtures. Base scope: Existing fixtures to remain. Alternate Scope: demo fixtures, install new LED fixtures as shown and specified on the electrical drawing sheets.

M. Add Alternate No. 13: Add window film at West side of Bridge. Window film to be applied to all glazing on exterior face, including spandrel lites. See 3/A3.a. Film to be similar to 3M Safety & Security Window Film

END OF SECTION
SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
   1. Section 00 72 00 “General Conditions of the Contract for Construction”.
   2. Section 01 60 00 “Product Requirements” for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit electronic copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Refer to Section 01 62 00.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
      b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. Certificates and qualification data, where applicable or requested.
      g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
      h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.

j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

k. Cost information, including a proposal of change, if any, in the Contract Sum.

l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.


   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Substitution request is fully documented and properly submitted.
      c. Requested substitution will not adversely affect Contractor's construction schedule.
      d. Requested substitution has been coordinated with other portions of the Work.
      e. Requested substitution provides specified warranty.

B. Substitutions for Convenience: Not allowed after Contract Award.
PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
   B. Related Requirements:
       1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK
   A. Architect will issue an Architectural Supplemental Instructions (ASI) authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710.

1.4 PROPOSAL REQUESTS
   A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

   1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
   2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

   a. The Contractor shall provide substantiation of costs. Labor, material and equipment should be broken out separately on subcontractor quotes.
   b. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   c. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
   d. Include costs of labor and supervision directly attributable to the change.
   e. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
f. Quotation Form: Use form provided by Contractor.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect. Send request to architect by e-mail in PDF form.

1. The Contractor shall provide substantiation of costs. Labor, material and equipment should be broken out separately on subcontractor quotes.
2. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
3. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
4. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
5. Include costs of labor and supervision directly attributable to the change.
6. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
7. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
8. Proposal Request Form: Use form provided by Contractor.

1.5 CHANGE ORDER PROCEDURES


1.6 CONSTRUCTION CHANGE DIRECTIVE


1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Coordination of Work of Contract from beginning of construction activity through Project close-out and warranty periods.
B. Related Sections:
   1. Section 007200 - General Conditions.
   2. Section 011100 - Summary of Work.
   3. Section 013300 - Submittal Procedures.
   4. Section 014500 - Quality Control.
   5. Section 015000 – Temporary Facilities and Controls
   7. Section 017329 – Cutting and Patching.
   8. Section 017700 – Closeout Procedures.
   9. Section 017800 - Closeout Submittals.
   10. Section 024119 – Selective Demolition.

1.2 SUBMITTALS
A. Coordination Drawings: Submit in accordance with Section 013300, and as specified herein.

1.3 COORDINATION SCHEDULING
A. Schedule Coordination: Special coordination and cooperation efforts are required for certain interrelated phases of the work, such as:
   1. Sequencing of remodeling work.
   2. Construction of temporary spaces and facilities;
   3. Removals and relocations of existing services and facilities;
   4. Connecting the Owner’s equipment;
   5. Installation of and connections to new utilities;
   6. Connections to existing buildings;
   7. Demolition work;
   8. Providing and maintaining temporary heat and other temporary facilities.
B. Coordinate scheduling, work activities, submittals, including deferred approvals (if any), Owner’s separate contracts (if any), Owner’s material/product direct purchase (if any), and work of the various sections of Specifications to ensure efficient and orderly sequence of installation of construction elements, with provisions for accommodating items to be installed later.
C. Coordinate sequence of Work to accommodate any Owner’s separate contracts and Owner Occupancy as specified in Section 011100.
D. General: The nature of the Project makes it imperative that the Contractor and all subcontractors coordinate their work and cooperate with each other and the Owner from the start of the Project to completion.
   1. The Contractor is the Prime Coordinator for the Project and shall establish the overall schedule for the progress of the Project, the sequence of completion and general use of the site.
E. Notice: Give adequate and timely notice of various work phases and operations which will affect the work of, or will require installations or other action by others.
   1. After timely notification by the Contractor of the need to accomplish a particular phase or element of the Work, the Subcontractors shall, within a reasonable time, perform their work as not to delay or impede others or the progress of the Project.
F. Schedule: Set up control procedures so that approved schedules are adhered to. Contractor’s responsibility is to properly notify Owner’s Representative of anticipated and actual time delays.
   1. Refer to General Conditions.

G. Contractor’s job superintendent shall be on the job during work activities.
   1. Refer to General Conditions.

H. The Contractor is responsible to coordinate the Work and cannot delegate responsibility for coordination to any Subcontractor.

I. The Contractor shall anticipate the interrelationship of all Subcontractors, Owner’s separate contracts, and their relationship with the Work.

J. The Contractor shall resolve differences or disputes between Subcontractors concerning coordination, interference, or extent of Work between Sections.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Not used.

PART 3 EXECUTION

3.1 SHUT DOWN PROCEDURES

A. A shutdown is any interruption of services provided by the Owner to its clients and staff. Ensure that an inspector has been assigned to coordinate shutdown in the field.

B. Determine if all proper and appropriate coordination and notification has been completed, before the shutdown.

C. Shutdown Request: Attached to the end of this section is a copy of the shutdown request form.

D. Write a final report to the Owner and Architect, in event of an unexpected incident that occurs during the course of a planned shutdown, resulting in a significant disruption or discontinuance of operations.

E. Interruption of Services: Adequate advance written notice (a minimum of fourteen (14) calendar days) shall be given to the Contractor and Owner’s Construction Administrator when interruptions of services, or interferences with the use of existing buildings and roads are anticipated. Contractor’s assigned subcontractor must not interrupt any service without written notice.

F. Planned service shutdowns shall be accomplished during periods of minimum usage. In some cases, this may require work outside of normal work hours at no additional cost to the Owner.
   1. The Contractor or assigned subcontractor must program the work so that service will be restored in the minimum possible time, and shall cooperate with the Owner in reducing shutdowns of system.
   2. At least fourteen (14) calendar days advance written notice shall be given to the Owner’s Representative before interruptions to service and other interferences to the use of, or access to existing buildings and facilities.
   3. Required access ways shall be kept open at all times; the use of one way traffic and detours shall be held to a minimum.

3.2 COORDINATION

A. Refer to Document 007200, General Conditions of the Contract for general requirements. Refer to other sections of Division 1 for requirements and timing relating to coordination, as well as other articles of this section.
   1. Submittals: Refer to Section 013300.
   2. Quality Control: Refer to Section 014500.
3. Closeout Procedures: Refer to section 017700.
4. Payments: Refer to General Conditions and Supplementary Conditions and Section 012900 - Price and Payment Procedures for progress payments and for final payment, as well as requirements of this Section.

B. The Prime Contractor shall be Project Coordinator and shall coordinate and schedule all work, including with the Owner where the work of the Contract may involve or disrupt the Owner’s normal functions.
   1. The Contractor and Subcontractors shall work closely in the coordination of the documents and in the timing of operations.

C. Service Connections: Except as otherwise indicated, final connection of mechanical services to general work is defined as being mechanical work, and final connection of electrical services to general work is defined as electrical work.

D. Service Shutdowns: Plan shutdowns so as to minimize shutdown time of any service. Request approval of a shutdown in writing to the Owner's Representative not less than fourteen (14) calendar days before the time that the shutdown is desired.

E. Hot Work: Consider hot work similar to utility shut downs and ensure proper safety measures are in place. Welding work shall require the same notification procedures as for shutdowns.
   1. Should operations be such that the requested shutdown be delayed in excess of ten working days from receipt of subcontractor’s written request, contract time extension will only be granted for the excess period.
      a. Operation of existing valves, switches, etc. to effect service shutdowns will be made by the Contractor.
   2. Although the general location of services may be shown on the drawings or described elsewhere, neither the Owner nor the Owner's Representative warrant the accuracy of the location shown or described.
   3. Responsibility for determining the actual on-site location of services shall rest solely with the Contractor’s subcontractors.
      a. Each subcontractor must verify the location of all services before commencing work.
      b. All capping, relocation or removal of such services shall be performed by each subcontractor at no increase in contract price.

F. Coordination: The Project will require close cooperation and coordination with Owner and Contractor and Subcontractors. The Contractor must:
   1. Consider such coordination in the work.
   2. Schedule the Work with the subcontractors and the Owner throughout the Project.
   3. Keep the Owner, and Architect advised of the schedule to complete the Work.

3.3 COORDINATION/ENGINEERING DRAWINGS:

A. Contractor is responsible for providing vertical sections through floors showing structural physical restraints, architectural restraints, plenum spaces and all other physical obstructions that may affect the work.
   1. Provide for integration of the work, including work first shown in detail on shop drawings or product data.
   2. Show sequencing and relationship of separate units of work which must interface in a restricted manner to fit in the space provided, or function as indicated.
   3. Coordination drawings must be definitive and detailed in nature.

B. Facilitate Coordination Drawing meetings with Subcontractors. If the size or complexity of the project requires it, Architect will be available, along with applicable engineers, to participate in these meetings as needed.

C. Prepare complete coordination drawings 1/4 inch = 1 foot 0 inches, including plans, sections, details, etc., indicating the complete layout and all mechanical and electrical equipment in all areas and within the ceiling spaces for new and existing conditions, including bottom of duct, pipe, conduit and elevations.
D. Contractor is responsible for coordination of each trades, including General, Mechanical, Fire Protection, Plumbing, Ceiling and Electrical Subcontractors.

1. Each of these Subcontractors shall be responsible to ensure that all relevant mechanical and electrical equipment, piping, conduit, ceiling hangers, etc., is shown on coordination and will fit.
2. Each Subcontractor must include all necessary items, i.e., lights, ducts, fans, pumps, piping, conduit, etc.

E. Conflicts shall be resolved by the Contractor. Contractor is the primary source responsible for conflict resolution.

F. Electronic reproduction or photo reproduction of Architectural drawings will not be acceptable.

G. Prepare a 1/4 inch sleeving layout indicating size and location of sleeves. Trades shall indicate their requirements and location.
   1. Provide copies to applicable trades and Architect.

H. At completion of work, coordination drawings shall be submitted together with record drawings of general, mechanical, electrical, plumbing and fire protection trades in accordance with Section 013300 – Submittal Procedures.

I. Review of Coordination/Engineering Drawings is for design intent only and shall not relieve the Contractor from overall responsibility for coordination of all work performed pursuant to the Contract, or from any other requirements of the Contract.

J. Debris Removal and Material Access: An area may be designated for debris removal and material access. Coordinate with Owner regarding access. At some County buildings (especially the Government Center), dock and dumpster space is limited and may require daily removal.

3.4 FLOORING COORDINATION

A. Hold a finish flooring coordination meeting. Invite suppliers and installers for the finish flooring. The purpose for this meeting is to coordinate concrete finishing, admixtures, curing compounds, moisture control and compatibility with finish flooring and adhesives.

3.5 EQUIPMENT COORDINATION

A. Install equipment in accordance with manufacturer’s recommendations and instructions.
   1. Refer to Section 016400 - Owner-Furnished Products.

B. Equipment Coordination: With respect to mechanical and electrical features of Contractor and Owner supplied equipment, complete data must be exchanged directly between the Contractor and those vendors and subcontractors involved as the progress of the Project requires.
   1. The person requesting the information shall advise when it will be required.
   2. Examine Owner’s existing equipment and determine the rough-in data. Owner will furnish data for equipment purchased by Owner. Unless noted otherwise, the Contractor will disconnect equipment and relocate to new space for connections by Contractor.
   3. Consult Owner to verify status of rough-in data.
   4. If rough-in details are not available at the time service systems are being installed, postpone final rough-in until data is available.

C. Subcontractors for casework and equipment are expressly required to provide large scale layout drawings for casework and equipment showing the required rough-in locations of all services (dimensioned from building features), service characteristics, and locations of studs where the location is critical to mounting or otherwise installing equipment and casework.
   1. Furnish sizes and spacing required for mechanical and electrical cutouts, and a complete brochure of fittings, sinks, outlets, or other information to provide complete data on the items and accessories being furnished.
D. In the event of incorrect, incomplete, delayed or improperly identified information, the entity causing the delay or error shall be responsible and pay for any modifications or replacements necessary to provide a correct, proper and new installation, including relocations required.

E. Services: Rough-in sleeves for waste and other services passing through the floor shall be installed prior to pouring the floors if data is available.
   1. Core drilling for holes may be done to facilitate job progress or to more accurately locate holes with permission of the Architect, without additional reimbursement.

F. Sleeves are required at core drilled holes. Where permission is obtained to omit sleeve, drill hole one inch larger than the outside diameter of the pipe or conduit, or one inch larger than outside diameter of insulation, where insulated.
   2. Refer to Section 017324 - Anchorage and Sleevng.

3.6 FIELD DIMENSIONS FOR CASEWORK AND EQUIPMENT
A. Accurate field dimensions are required in ample time to permit fabrication of casework and equipment for delivery and installation in accordance with the schedule.
   1. Contractor and subcontractors to coordinate with each other to obtain dimensions and to prevent fabrication delay, cooperate in completing work phases to accommodate the schedule.

3.7 MEETINGS
A. Pre-Construction Meeting: After award of contract, at time designated by the Owner or the Architect, the Contractor and major subcontractors shall attend a Pre-Construction Meeting.
   1. Procedures to be followed, critical work sequencing, coordination efforts and similar matters will be reviewed.

B. Progress Meetings: During construction, periodic site meetings will be held with the Contractor, major Subcontractors, Owner, and Architect.
   1. These meetings will be held weekly and may be held more frequently if job progress and needs indicate.
   2. Contractor and major Subcontractors shall have one or more responsible representatives in attendance.
   3. Architect to run the meetings and distribute the minutes to all participants.

C. In addition to progress meetings specified herein, hold coordination meetings and pre-installation conferences with requisite personnel to ensure coordination of Work specified in individual Sections..

3.8 COORDINATION OF SCHEDULES, SUBMITTALS
A. Coordinate schedules, reports, and payments as specified in Section 013300 and as specified in Section 017800.

B. Schedule and coordinate submittals specified in Section 013300 and as specified in Section 017700.

C. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate requests for substitutions to ensure compatibility of space, of operating elements, and effect on work of other sections.

3.9 COORDINATION OF SPACE
A. Coordinate use of Project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on Drawings.
   1. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building.
2. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

B. In finished areas, except as otherwise shown, conceal pipes, ducts, and wiring in the construction. Coordinate locations of fixtures and outlets with finish elements.

C. Off-Site Fabrication: Off-site fabrication is encouraged as much as possible and deliveries scheduled so materials and equipment can be installed immediately after delivery.
   1. Alert and advise others of the need to hold deliveries until they are notified the materials are required on the site.

D. Notice: Give adequate and timely notice of various work phases and operations which will affect the work of, or will require installations or other action by others.
   1. After timely notification by the Contractor of the need to accomplish a particular phase or element of the Work, the Subcontractors shall, within a reasonable time, perform their work as not to delay or impede others or the progress of the Project.

E. Coordination of phases of the work: Special coordination and cooperation efforts are required for certain interrelated phases of the work, such as:
   1. Sequencing of remodeling work; construction of temporary spaces and facilities; removals and relocations of existing services and facilities; ceiling work; connecting the Owner's equipment; installation of and connections to new utilities; connections to existing buildings; demolition work; providing and maintaining temporary heat and other temporary facilities; and similar work.

3.10 COORDINATION OF CLOSEOUT PROCEDURES

A. Coordinate completion and cleanup of work of separate trades in preparation for Owner occupancy.

B. After Owner occupancy of premises, coordinate access to site by various trades for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

C. Assemble and coordinate closeout submittals specified in Section 017800.
REQUEST FOR FACILITIES SHUTDOWN

To: ___________________________ Phone: ___________________________

Date: ___________________________

Project Name: ___________________________

Project Number: __________________ Project Superintendent: ___________________________

Contractor Requiring Shutdown: ___________________________

Contact Person: ___________________ Contact Phone: ___________________

Cell Phone: ___________________

Type Of Utility Service:

☐ Electrical ☐ Deionized Water Fire
☐ Alarm ☐ Domestic Hot Water
☐ HVAC ☐ Domestic Cold Water
☐ Hot Water Heating ☐ Sanitary Sewer
☐ Steam ☐ Natural Gas
☐ Condensate ☐ Fire Protection
☐ Medical Gas ☐ Other ___________________________

Work Area Location: ___________________________

Tentative Shutdown Time: ___________ Month, Day, Year: ___________________________

Approximate Length of Downtime: ___________________________

Reason for Shutdown: ___________________________

________________________________________

________________________________________

________________________________________

________________________________________

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's Construction Schedule.
3. Construction schedule updating reports.
4. Daily construction reports.
5. Material location reports.
6. Site condition reports.
7. Unusual event reports.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:
   1. Working electronic copy of schedule file, where indicated.
   2. PDF file. Submit to Architect by e-mail. Architect to upload final submittal to web-based construction management software.

B. Startup construction schedule.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
   1. Submit a working digital copy of schedule, using web-based construction management software, and labeled to comply with requirements for submittals.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
   1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
   2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.

F. Construction Schedule Updating Reports: Submit with Applications for Payment.

G. Daily Construction Reports: Submit at weekly intervals.

H. Material Location Reports: Submit at weekly intervals.

I. Site Condition Reports: Submit at time of discovery of differing conditions.

J. Unusual Event Reports: Submit at time of unusual event.

K. Qualification Data: For scheduling consultant.
1.5 **QUALITY ASSURANCE**

A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Discuss constraints, including phasing, work stages, interim milestones and partial Owner occupancy.
2. Review delivery dates for Owner-furnished products.
3. Review submittal requirements and procedures.
4. Review time required for review of submittals and resubmittals.
5. Review requirements for tests and inspections by independent testing and inspecting agencies.
6. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
7. Review and finalize list of construction activities to be included in schedule.
8. Review procedures for updating schedule.

1.6 **COORDINATION**

A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

1.7 **CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL**

A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion and Final Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
5. Commissioning Time: Include no fewer than 15 days for commissioning.
6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work under More Than One Contract: Include a separate activity for each contract.
3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 01 11 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01 11 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
6. Work Restrictions: Show the effect of the following items on the schedule:
   a. Coordination with existing construction.
   b. Limitations of continued occupancies.
   c. Uninterruptible services.
   d. Partial occupancy before Substantial Completion.
   e. Use-of-premises restrictions.
   g. Seasonal variations.
   h. Environmental control.

7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Mockups.
   e. Fabrication.
   f. Sample testing.
   g. Deliveries.
   h. Installation.
   i. Tests and inspections.
   j. Adjusting.
   k. Curing.
   l. Building flush-out.
   m. Startup and placement into final use and operation.
   n. Commissioning.

8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Temporary enclosure and space conditioning.
c. Permanent space enclosure.
d. Completion of mechanical installation.
e. Completion of electrical installation.
f. Substantial Completion.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to Substantial Completion, and final completion.

F. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.

G. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

H. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

I. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

J. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.8 GANTT-CHART SCHEDULE REQUIREMENTS

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed.
1. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Preconstruction photographs.
   2. Final completion construction photographs.
   3. Preconstruction video recordings.

B. Related Requirements:
   1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
   2. Section 024119 "Selective Demolition" for photographic documentation before selective demolition operations commence.

1.3 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit image files within three days of taking photographs.
   1. Label and submit photos by uploading to web-based project software site. Include copy of key plan indicating each photograph’s location and direction.
   2. Identification: Provide the following labeled information with each image on the web-based project software site:
      a. Name of Project.
      b. Name and contact information for photographer.
      c. Name of Architect.
      d. Name of Contractor.
      e. Date photograph was taken.
      f. Description of location, vantage point, and direction.
      g. Unique sequential identifier keyed to accompanying key plan.

C. Post and maintain on web-based project software Download and provide on thumbnails at project closeout.
1.4 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.

C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

D. Metadata: Record accurate date and time and GPS location data from camera.

E. File Names: Name media files with date and Project area and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Project superintendent, or other appropriately skilled employee to take construction photos.

B. General: Take photographs with maximum depth of field and in focus.
   1. Maintain key plan with each set of construction photographs that identifies each photographic location.

C. Preconstruction Photographs: Before commencement of demolition take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
   1. Flag construction limits before taking construction photographs.
   2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
   3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
   4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Periodic Construction Photographs: Take 50 photographs weekly coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

E. Time-Lapse Sequence Construction Photographs: Take 20 photographs as indicated, to show status of construction and progress since last photographs were taken.
   1. Frequency: Take photographs weekly, on the same day each week.
   2. Vantage Points: Following suggestions by Architect, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time-lapse sequence as follows:
a. Exterior building enclosure.
b. Interior Work, through date of Substantial Completion.

F. Final Completion Construction Photographs: Take 100 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.

G. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum or in the allowance for construction photographs.

1. Three days’ notice will be given, where feasible.
2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:
   a. Special events planned at Project site.
   b. Immediate follow-up when on-site events result in construction damage or losses.
   c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
   d. Substantial Completion of a major phase or component of the Work.
   e. Extra record photographs at time of final acceptance.
   f. Owner’s request for special publicity photographs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Procedures for submittals.

B. Related Sections:
   1. General Conditions: General Requirements.
   2. Section 011100 - Summary of Work.
   3. Section 013100 - Project Management and Coordination.
   4. Section 013310 – Submittal Transmittal.
   5. Section 017700 - Closeout Procedures.
   6. Section 017800 - Closeout Submittals.

1.2 SUBMITTAL SCHEDULE

A. Prepare and submit "Submittal Schedule" within 10 days after award of Contract. Include following information.
   1. Specification Section Number.
   2. Type of submittal required.
   3. Estimated time for submittal review.

B. Coordinate, organize and plan submittal schedule so submittals are sent with appropriate time allowed for adequate professional review and so submittals do not accumulate into unusually large groups. In no case should less than 15 working days be scheduled for submittals review.
   1. Plan additional time for submittals that require time for coordination, routing and review including, but not limited to, following:
      a. Large groups of submittals.
      b. Hardware and doors.
      c. Integrated systems.
      d. Unique design elements or systems.
      e. Submittals that need to be routed to multiple disciplines and consultants.
      f. Other submittals identified by Architect.

1.3 TRANSMITTAL FORM

A. Send submittals with "Submittal Transmittal Form" Section 013310 completely filled out with appropriate information.

B. Submittals sent without properly completed "Submittal Transmittal Form" will be considered incomplete and marked "Not Accepted" and returned without review.

C. Send separate transmittal forms for each Section and separate transmittals for each type listed:
   1. Shop Drawings.
   2. Product Data.
   3. Samples.

D. If shop drawings, samples or product data describe the same product or item, send submittals together under same transmittal otherwise send each type submittal under separate transmittals.
E. If submitting electronically through a web-based construction management program, a “Submittal Transmittal Form” must be completed and included as the first page of the single PDF submittal document.

1.4 SUBMITTAL ACCEPTANCE

A. Refer to General Conditions for scope of submittal review and acceptance.

B. Substitutions or Contract modifications shall not be made in submittals. Exceptions and variations must be clearly noted on submittal and accompanied by the appropriate supporting forms. Follow documented procedures for substitutions or Contract modifications and send with submittal if a change is being proposed. Approval of a submittal with substitutions or modifications included that have not been specifically and individually approved does not constitute acceptance of the substitution and Contractor will be responsible for exception or variations not in compliance with Contract Documents.

C. For submittals need to be resubmitted after the first review, Contractor will be responsible for Architects fees for more than the second review unless otherwise agreed.

D. Maintain copies of “Approved” and “Conditionally Approved” submittals with record set per 017800.

E. "Approved" submittals have no exceptions noted. One set of accepted submittals will be returned to Contractor. Make appropriate copies for use and distribution.

F. "Conditionally Approved" submittals have exceptions noted but resubmission is not required. Make appropriate copies for use and distribution.

G. "Not Approved" submittals are incomplete and/or need corrections. Complete and/or correct and resubmit until final acceptance is obtained.

H. "Received" means submittals are for information only and have not been reviewed.

I. "Not Reviewed" means submittals were not required and have not been reviewed or were provided for information only.

1.5 CONTRACTOR’S PLAN OF OPERATION

A. Submit at Pre-Construction Conference. Refer to Section 013100.

B. Outline in writing approach to meeting schedule for completing Work.

C. Plan to include, but not limited to, following:
   1. Sequence of Work.
   2. Construction Schedule.
   4. Schedule of Temporary Utilities.
   5. Staging requirements/street permits.
   6. Normal work hours.
   7. Parking exceptions
   9. Name of person to be liaison to adjacent property Owners.
   10. Name of duly authorized representative with whom business may be conducted in connection with administration of Contract.
   11. Name of duly authorized superintendent written notices may be given in accordance with Conditions of the Contract.
   12. Labor and equipment availability
   13. List of Subcontractors
   14. Names of contact persons with Owner, Architect and Contractor
15. Proposed schedule of Progress Meetings in accordance with Section 013100 and schedule of submittals per Section 013310 and payment requests per Section 012900, and other reports required by Contract Documents.

1.6 COORDINATION

A. Send submittals in logical groups of related items including but not limited to the following groups:
   1. Submittal schedule, list of materials, list of subcontractors, schedule of values
   2. Doors, frames and hardware.
   3. Closeout submittals: Refer to Section 017800.

1.7 DISTRIBUTION

A. Contractor is responsible for duplication and distribution of accepted submittals including shop drawings. Exchange directly with subcontractors and others involved, not through Owner or Architect.

B. Provide and exchange submittals as needed to coordinate Work.

C. Provide copies to Owner if Owner requests copies during construction. Otherwise Owner will receive accepted submittals as part of Record Set submitted during project closeout.

1.8 ELECTRONIC SUBMITTALS

A. Electronic submittals is the preferred method of review. Follow these procedures:
   1. Provide one pdf file for each submittal to Submittals Coordinator. PDF file must be unlocked, editable and printable to accommodate electronic mark-ups or printing a hard copy from mark-up.
   2. Electronic submittals are to be complete and self-contained with each item requiring Architect’s action.
      a. Web links or other electronic submittals requiring Architect to surf websites or navigate to find documents on websites or posting services are not acceptable.
      b. If construction phase file hosting services or programs are used such as Prolog, Primavera or documents hosting programs may be considered subject to coordination with Architect.
      c. Such procedures should not require Architect to search for submittals but should follow procedures that are the electronic equivalent of hard copy submittals sent by Contractor to Architect in a manner acceptable to Architect.
   3. Where project data is intended to show colors, provide original hard copy only. See Product Data herein. No electronic submittals for color submittals.
   4. Submit samples according to Samples article herein. No electronic submittals for samples will be permitted.
   5. Architect will return one marked up electronic submittal for Contractor to process and distribute to subcontractors and for Owner according to Distribution article requirements herein.
   6. On each electronic submittal, provide Contractor review and approval stamp on each submittals.

1.9 SHOP DRAWINGS

A. Use of Architect's Drawings: Do not reproduce Architect's drawings (whether CADD files, electronic files, hard copy drawings or other publication method) to serve as shop drawings until Architect's written permission is received and then only under the following conditions.
   1. Use is subject to terms and conditions included in written permission.
   2. Use only where necessary to indicate general location of a specific fabricated item.
   3. Remove extraneous notes and information from Drawing before inclusion in submittal. Only show information related to fabrication, erection, installation, application of components,
products or systems being produced. Do not include Architect's title block or other information identifying Architect.

4. Submitted drawing should only include information intended to be reviewed and accepted.
5. Refer to Summary of Work for additional information on Electronic files.

B. Drawings that include unnecessary information will be marked "Not Reviewed" or "Not Approved" and returned.

C. Shop drawings submitted without requested information and without Contractor's approval will not be reviewed and will be returned to Contractor marked "Not Approved."

D. Drawings Submittal Requirements:
   1. Submit drawings electronically.
   2. Architect will retain a copy.
   3. Provide additional copies for other contractors for purposes of information and coordination.
   4. Number in submittal sequence.
   5. Include Contractor’s stamp of approval, as evidence that drawings are approved in accordance with General Conditions except that field dimensions must be verified prior to approval and submittal.
   6. Show field verified dimensions on final shop drawings and identify verified dimensions.
   7. Show actual adjacent construction and how each item coordinates with other subcontractors, trades and suppliers.
   8. Drawings must be clear, sharp and readable quality acceptable to Architect/Engineer.
   9. Provide clear space on each drawing of not less than 40 square inches for Architect's stamp.

E. Maintain accepted shop drawings as part of "Record Set." See 017800.

1.10 PRODUCT DATA AND EQUIPMENT BROCHURES

A. Provide multiple originals of brochures, cuts, etc., if they are multi-page bound catalogs which would be difficult to photocopy or if they are intended to illustrate color or other appearance characteristics which cannot be adequately represented by photocopies. Electronic information is preferred.

B. Photocopies of original brochures are acceptable except as specified above. Photo copies must be clear and readable. Unreadable or unclear photocopies will be returned "Not Accepted."

C. Provide layout drawings where necessary for field use or as required by Architect.

D. Number of Copies of Product Data:
   1. Submit electronically
      a. Architect will retain 1 copy.
   2. Number in submittal sequence.
   3. Include Contractor's stamp of approval, as evidence that drawings are approved in accordance with General Conditions (including field dimensions).
   4. Indicate field verified information as applicable.
   5. Provide clear space of not less than 40 square inches for Architect's stamp.

E. Provide an index of each page in submittal with space for notes and acceptance stamps.

F. Warranties:
   1. Where warranty is indicated, submit manufacturers’ sample warranty with shop drawings.
   2. Submit actual executed warranties or guarantees per Section 017700 and 017800.

1.11 SAMPLES
A. Deliver samples of materials, equipment, assemblies and components as required by specifications to Architect/Engineer with delivery costs prepaid. At Architect's/Engineer's direction, remove samples after approval.
   1. Provide samples representative of actual product including finishes and other specified characteristics.
   2. Indicate type of construction and quality proposed for installation in Project.

B. Number of Samples:
   1. Submit 3 samples unless otherwise specified.
      a. One set of samples to be retained by Architect.
      b. One set of sample to be retained by Contractor at the jobsite.
   2. Provide additional samples for other contractors for purposes of information and coordination.

C. Maintain record samples of accepted samples with other record documents at project site.

1.12 LIST OF MATERIALS

A. Submit within 10 days after award of Contract and prior to purchase.

B. Submit 1 copy of complete list of materials, products, and equipment proposed to be used to Architect/Engineer for acceptance.

C. Do not order materials or equipment until proposed list of materials is accepted.

D. Materials and equipment are subject to Architect's and Owner's acceptance.

E. Arrange list in order of specification sections and in form indicated by Architect/Engineer.
   1. Items listed shall fully conform to project requirements and specifications.
   2. Specifically identify each material, product or equipment item by manufacturer, brand and model and other identifying designations including those where only 1 material or product is specified.
   3. Name products specified by reference standards, described by performance requirements and descriptive language.
   4. Do not list "as specified."

F. Where 2 or more makes or kinds of items are named in specifications (or additional names are listed in an addendum), state which particular make or kind of each item is to be provided.

1.13 LIST OF SUBCONTRACTORS

A. Submit within 10 days after award of Contract, and prior to execution of Contract.

B. Submit with List of Materials.

C. Submit 1 copy of a complete list.

D. Do not execute subcontracts until proposed list of subcontractors is accepted by Owner, Architect and Engineers.

E. List to include the following information and be in form indicated by Architect.
   1. Description of work proposed to be done by subcontract.
   2. Names of subcontractors and major material suppliers proposed to perform portions of Work.
   3. Names of sub-subcontractors of mechanical and electrical subcontractors.
   4. Include proposed sub-subcontractors for other trades as requested by Architect and Engineers.

F. Reasonable objection may arise when, in opinion of Architect or Owner, there exists a rational belief that proposed subcontractor, sub-subcontractor or material supplier:
   1. Cannot provide materials, equipment, facilities or other products as specified or required by Contract Documents;
   2. Cannot provide labor and skill necessary to accomplish part of Work for which they are proposed, including but not limited to quality of work;
3. Lacks adequate and appropriate experience for that part of Work proposed, including materials or methods required;
4. Has previously failed to perform in timely or satisfactory manner, including in cooperation and in necessary services after project completion;
5. Proposes deviations in materials or methods that are unacceptable to Architect or Owner, such as proposing materials or products that were not specified or not listed in addenda;
6. Cannot satisfactorily perform part of Work for which contractor is proposed, within time schedule, due to size of organization or existing work load.
7. Cannot demonstrate ability through quality of representative work to perform part of Work for which contractor is being considered;
8. Of questionable integrity;
9. Shows evidence of similar considerations bearing on possibility of unsatisfactory performance.

G. If Owner or Architect has a reasonable objection to person or entity proposed by Contractor to do portion of Work, Contractor must submit substitute to whom neither Owner nor Architect has reasonable objection; no increase in Contract Sum shall be allowed as a result of such substitution.

H. After acceptance of proposed list, no change of subcontractor, sub-subcontractor or supplier not objected to by Architect or Owner, shall be made, except for cause acceptable to Architect and Owner.
   1. In event of a proposed change, submit reasons for change, in writing, along with alternate proposed subcontractor, sub-subcontractor or material supplier.
   2. Proposed change is subject to conditions of this Article and requirements of General Conditions.

1.14 CLOSE-OUT SUBMITTALS

A. Submit documents specified under Section 017700 and 017800.

B. Submit 1 hard copy and 1 digital copy (disk, USB drive, etc.) of operating instructions and maintenance manuals to Owner at time of Owner's instructions.

1.15 OTHER SUBMITTALS

A. Provide other required submittals as specified.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION
SECTION 013310
SUBMITTAL TRANSMITTAL

To: Fill in Firm Name and Address  From: (Contractor)
Attn: Submittals Coordinator (Address)
1234 Street (Address)
Minneapolis, Minnesota 55401 (City, State)

Email: Firm Email
Owner: Hennepin County
Project: Project Name
Commission No.: Submittal Date:

Previous Submittal Date:

Incomplete submittals will be returned "Not Accepted." See General Conditions and 013300 for requirements.

The following submittal(s) is (are) attached for your review as required by the Contract Documents.

SHOP DRAWINGS

☐ No. copies submitted. Submit minimum 1 PDF per 013300; complete the following information:
☐ Partial ☐ Complete ☐ Preliminary ☐ Final
List of Drawings:

☐ Specification Section:
☐ Article & Paragraph:
☐ Description of
☐ Manufacturer:
☐ Supplier’s Name:
☐ Telephone Number:

PRODUCT DATA AND QUALITY CONTROL

☐ No. copies submitted. Submit minimum 1 PDF per 013300; complete the following information:
☐ Partial ☐ Complete ☐ Preliminary ☐ Final
List of Items:

☐ Specification Section:
☐ Article & Paragraph:
☐ Description of
☐ Manufacturer:
☐ Supplier’s Name:
☐ Telephone Number:

SAMPLES

☐ No. copies submitted. Submit minimum 3 copies per 013300; complete the following information:
☐ Partial ☐ Complete ☐ Preliminary ☐ Final
List of Items:

☐ Specification Section:
☐ Hennepin County Submittal Procedures
☐ North Regional Library Refurbishment

013300-7
Description of Item:
Manufacturer:
Supplier’s Name:
Telephone Number:

Submitted By: Company Name:

Phone:

Signature:
SECTION 013310
SUBMITTAL TRANSMITTAL

To: Fill in Firm Name and Address
From: (Contractor)
Attn: Submittals Coordinator
1234 Street
Minneapolis, Minnesota 55401
(Contractor) (Address) (Address) (City, State)

Email: Firm Email
Owner: Hennepin County
Project: Project Name
Commission No.: 
Submittal Date: ________________
Previous Submittal Date: ________________

Incomplete submittals will be returned “Not Accepted.” See General Conditions and 013300 for requirements.
The following submittal(s) is (are) attached for your review as required by the Contract Documents.

### SHOP DRAWINGS

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<tr>
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<th>Supplier’s Name:</th>
<th>Telephone Number:</th>
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</thead>
</table>

Submitted By: Company Name: ____________________________

Hennepin County
North Regional Library Refurbishment

Submittal Transmittal
013310 - 1
Phone: _________________________________

Signature: _______________________________
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes special procedures for art collections preservation work.

B. Art Removal: By KCI Conservation as a subcontractor to the Contractor for the removal, storage, return, and replacement of the existing artwork. The art move-out to occur prior to start of construction, concurrent with library move-out. Contractor to coordinate the work with Hennepin County and KCI Conservation. Contact Information: Phone: 612-564-3176, Email: kciconservation@gmail.com, Kristin Cheronis and Laura Kubick.

1.3 COORDINATION

A. Art collections preservation work sub-schedule: A construction schedule coordinating the sequencing and scheduling of art collections preservation work for the Project, including each activity to be performed, and coordinated with the Contractor's Construction Schedule. Secure time commitments for performing critical activities from separate entities responsible for the work.

1. Schedule construction operations in sequence required to obtain best Work results.

2. Coordinate sequence of work activities to accommodate the following:

   a. Packaging and removal of artwork. Mark locations and artwork from where it was removed.

   b. Delivery of artwork to Hennepin County storage facility. The art shall be stored at Minneapolis Central Library, 300 Nicollet Mall, Minneapolis, MN 55401.

   c. Delivery of artwork back to North Regional Library to occur after Project Substantial Completion and before Final Completion.

   d. Unpacking of artwork and placing artwork as coordinated with the Owner.

3. Detail sequence of art collections preservation work, with start and end dates.

B. Pedestrian and Vehicular Circulation: Coordinate work with circulation patterns within Project building and site.

1.4 PROJECT MEETINGS FOR ART COLLECTIONS PRESERVATION WORK

A. Preliminary Conference for Art Collections Preservation Work: Before starting the construction of the project work, Architect will conduct conference at Project site

1. Attendees: In addition to representatives of Owner, Architect, and Contractor, shall be represented at the meeting.

2. Agenda: Discuss items of significance that could affect progress of Art Collections Preservation work, including review of the following:
a. Work Sub-schedule: Discuss and finalize; verify availability of materials, specialists’ personnel, equipment, and facilities needed to make progress and avoid delays.

b. Fire-prevention plan.

c. Areas where existing construction is to remain and the required protection.

d. Hauling routes.

e. Sequence of Art Collections Preservation work operations.

f. Storage, protection, and accounting for artwork.

g. Existing conditions, staging, and structural loading limitations of areas where materials are removed.

h. Qualifications of personnel assigned to Art Collections Preservation work and assigned duties.

i. Requirements for extent and timing of the removal of the artwork.

3. Reporting: Architect will record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.

1.5 MATERIALS OWNERSHIP

A. Artwork items such as paintings, sculptures, and similar objects including, but not limited to, commemorative plaques and tablets, antiques, and other items of interest or value to Owner, remain Owner's property.

1. Carefully remove and package each item of artwork in a manner to prevent damage and protect it from damage, then promptly deliver it to Owner's storage facility. See Article 1.3.

1.6 INFORMATIONAL SUBMITTALS

A. Work Sub-schedule:

1. Submit work sub-schedule within seven days of date established for commencement of work.

B. Preconstruction Documentation: Show preexisting conditions of adjoining construction to remain, including finish surfaces, that might be misconstrued as damage caused by subcontractor’s Art Collections Preservation work operations.

1.7 QUALITY ASSURANCE

A. Specialist Qualifications: An experienced firm regularly engaged in specialty work similar in nature, materials, design, and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.

1. Field Supervisor Qualifications: Full-time supervisors experienced in specialty work similar in nature, and extent to that indicated for this Project. Supervisors shall be on-site when specialty work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.

B. Art Collections Preservation Work Program: Prepare a written plan for the work for the whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate with whole-Project construction schedule with specific requirements of required in other work Sections.
1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.

1.8 STORAGE AND HANDLING OF SALVAGED ART MATERIALS

A. Salvaged Art Materials:

1. Clean loose dirt from salvaged artwork items unless more extensive cleaning is indicated.
2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
3. Transport items to Owner’s storage area. Protect items from damage during transport and storage. See Article 1.3. This storage space includes Owner provided security and climate control for stored material. Owner provides insurance for stored artwork.

B. Salvaged Art Collections for Reinstallation:

1. Protect items from damage during transport and storage.
2. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.

1.9 FIELD CONDITIONS

A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of preconstruction photographs and preconstruction videotapes.

1. Comply with requirements specified in Section 01 32 33 "Photographic Documentation."
2. See attached survey of art collections updated October, 2019.

B. Size Limitations in Existing Spaces: Materials, products, and equipment used for performing the Work and for transporting art collections materials, shall be of sizes that clear surfaces within existing spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 SECURITY

A. The art collections subcontractor contractor shall notify the client in advance of work schedules and changes so that security can be maintained.

B. Workmen cannot enter Owner’s limited-access art collection storage without staff knowledge.

3.2 PROTECTION FROM FIRE

A. Fire-Control Devices: Contractor to provide and maintain fire extinguishers. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher use.
B. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.

3.3 GENERAL ART COLLECTION PRESERVATION WORK

A. Specialty art removal work shall be performed only by KCI Conservation.

B. Ensure that supervisory personnel are present when work begins and during its progress.

C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs and video recordings. Comply with requirements in Section 01 32 33 "Photographic Documentation."

D. Perform survey of Project site as the Work progresses to detect hazards that may affect the removal of the artwork.

END OF SECTION
<table>
<thead>
<tr>
<th>Title</th>
<th>Artist</th>
<th>Materials</th>
<th>Synopsis</th>
<th>Structural Condition Comments</th>
<th>Surface Condition Comments</th>
<th>Condition Summary</th>
<th>Conservation Priority</th>
<th>Treatment Required by Conservator</th>
<th>KCI Treatment Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turning Leaves, 2006</td>
<td>Wing Young Huie</td>
<td>wood</td>
<td>these are in fair to good condition. They are sided, with heavy grime and accretions. There are many shallow scratches and scuffs, particularly on the finely leaf walnut. The cherry leaf is also exhibiting heavy scratching. They are getting some hard wear. There are also many dark scuffs and abrasions, especially on the lower 2-3 year sunburns or other equipment hitting them. There are numerous splits along the bonded pieces of the joining, but they appear to be stable.</td>
<td>dust, accretions, minor scratches, scuffs, grime, incised, scratched</td>
<td>fair</td>
<td>2-High</td>
<td>dust off debris, such as gum wrappers daily. Wipe with damp cloth once water only monthly.</td>
<td>The three benches should be cleaned well to remove heavy grime, etc. Tone and reduce the scratch it as possible. The old wax coating should be removed. They should be waxed and polished.</td>
<td>$2,540.00</td>
</tr>
<tr>
<td>Boy with a Kite, 1989</td>
<td>Malcolm Moran</td>
<td>wood</td>
<td>the sculpture is in good condition. It was made in a case so the structurally stability could not be fully assessed, but there were no obvious structural problems. The blue-glass collection on the surface appear at first to be corrosion, but it actually an intentional patina on the surface this was confirmed by calling the artist's studio. The case is dusty and has fingerprints. There are accretions on the Plexiglas case.</td>
<td>dust, accretions, grime</td>
<td>good</td>
<td>3-Medium</td>
<td>case could be wiped with a slightly damp cloth</td>
<td>Dust with vacuum. Carry out light surface cleaning of sculpture. Surface clean case. Attempt to polish Plexiglas to remove or reduce scratches.</td>
<td>$450.00</td>
</tr>
<tr>
<td>Girl with a Balloon, 1974/75</td>
<td>Malcolm Moran</td>
<td>wood, glass, and wood case</td>
<td>the sculpture is in good condition. It was inside a case so the structurally stability could not be fully assessed, but there were no obvious structural problems. The blue-glass collection on the surface appear at first to be corrosion, but it actually an intentional patina on the surface this was confirmed by calling the artist's studio. The glass balloon appeared to be in good condition. There is heavy dust on the sculpture and base despite being inside a case. The case is has light grime, accretions, and dust.</td>
<td>dust, accretions, grime</td>
<td>good</td>
<td>3-Medium</td>
<td>case could be wiped with a slightly damp cloth</td>
<td>Dust with vacuum. Carry out light surface cleaning. Surface clean case.</td>
<td>$290.00</td>
</tr>
<tr>
<td>Neighborhood Walk to Your Library Event mobile</td>
<td>W0li-Minneapolis Community</td>
<td>paper, monofilament, wire, string</td>
<td>the organ paper colors, transcription, and marking are in good condition. Everything is structurally sound at this time. There is moderate dust on all parts, especially on horizontal surfaces and the ends of monofilament. Some of the papers are exhibiting slight to moderate fading, depending on the color. The fading is due to light exposure and will continue.</td>
<td>dust, fading</td>
<td>good</td>
<td>2-Low</td>
<td>Visual or bristle brush cleaning with vacuum by conservator</td>
<td>Dust all with vacuum.</td>
<td>$140.00</td>
</tr>
<tr>
<td>Photograph of Yesterday, 2006</td>
<td>Wing Young Huie</td>
<td>mounted photos</td>
<td>the photos on treated Azo wall, mounted between glass and board. These are in good condition with only light dust, a few light scratches, and a few in the local areas such as tape residue. 10 photos on board wall with text are not placed. These appear to be mounted with velcro, which is fine. Most of these are in excellent condition, because they are not accessible. However, there is a test panel with a metal core and one test panel with a dashed corner. The only other issue they have at this time is dust on their surfaces.</td>
<td>dust, accretions, scratches</td>
<td>excellent</td>
<td>4-Low</td>
<td>Visual or bristle brush cleaning with vacuum by conservator</td>
<td>Dust all photos with a vacuum.</td>
<td>$400.00</td>
</tr>
</tbody>
</table>

**Synopsis**
- Wing Young Huie
- Malcolm Moran
- Malcolm Moran
- Marjorie Pitz

**Materials**
- mounted photos
- ring
- monofilament, wire
- paper, and wood case
- Plexiglas and wood
- wire, bronze sheet, wood

**Surface Condition**
- dust
- accretions
- grime
- scratches

**Treatment Required by Conservator**
- dust off debris, such as gum wrappers daily. Wipe with damp cloth once water only monthly. dust off debris, such as gum wrappers daily. Wipe with damp cloth once water only monthly. dust off debris, such as gum wrappers daily. Wipe with damp cloth once water only monthly. dust off debris, such as gum wrappers daily. Wipe with damp cloth once water only monthly.

**KCI Treatment Cost Estimate**
- $2,540.00
- $450.00
- $290.00
- $140.00
- $400.00

**TOTAL**
$2,540.00
SECTION 01 42 00
REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

4. AASHTO - American Association of State Highways and Transportation Officials; www.transportation.org.
7. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
8. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
9. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
15. AIA - American Institute of Architects (The); www.aia.org.
24. ASCE - American Society of Civil Engineers; www.asce.org.
25. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformite Europeenne; http://ec.europa.eu/growth/single-market/ce-marking/
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFMA - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
58. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
63. CSA - CSA Group; www.csa.ca.
64. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csainternational.org.
65. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
68. CWC - Composite Wood Council; (See CPA).
70. DHI - Door and Hardware Institute; www.dhi.org.
71. ECA - Electronic Components Association; (See ECIA).
72. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. EIA - Electronic Industries Alliance; (See TIA).
77. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
78. ESTA - Entertainment Services and Technology Association; (See PLASA).
79. ETL - Intertek (See Intertek); www.intertek.com.
81. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
82. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
90. GA - Gypsum Association; www.gypsum.org.
92. GS - Green Seal; www.greenseal.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
100. IAS - International Approval Services; (See CSA).
101. ICBO - International Conference of Building Officials; (See ICC).
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICMA - International Cast Polymer Alliance; www.icpa-hq.org.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
114. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
115. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
116. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
117. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
119. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
120. ITU - International Telecommunication Union; www.itu.int/home.
121. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
122. LMA - Laminating Materials Association; (See CPA).
125. MCA - Metal Construction Association; www.metalconstruction.org.
134. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
139. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
140. NCMA - National Concrete Masonry Association; www.ncma.org.
142. NECA - National Electrical Contractors Association; www.necanet.org.
144. NEMA - National Electrical Manufacturers Association; www.nema.org.
146. NFHS - National Federation of State High School Associations; www.nfhs.org.
148. NFPA - NFPA International; (See NFPA).
151. NLGA - National Lumber Grades Authority; www.nlga.org.
152. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
154. NRCI - National Roofing Contractors Association; www.nrca.net.
159. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
161. PCI - Precast/Prestressed Concrete Institute; www pci.org.
162. PDI - Plumbing & Drainage Institute; www.pdionline.org.
163. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); http://www.plasa.org.
168. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
169. SDI - Steel Deck Institute; www.sdi.org.
170. SDI - Steel Door Institute; www.steeldoorg.org.
171. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
172. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
175. SMA - Screen Manufacturers Association; www.smainfo.org.
176. SMACNA - Sheet Metal and Air Conditioning Contractors’ National Association; www.smacna.org.
177. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
178. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
186. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
187. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
190. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
191. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
194. TPI - Turfgrass Producers International; www.turfgrasssod.org.
197. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
198. USAV - USA Volleyball; www.usavolleyball.org.
201. WA - Wallcoverings Association; www.wallcoverings.org
203. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
204. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
208. WWPA - Western Wood Products Association; www.wwpa.org.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Procedures to measure and report the quality and performance of construction.
B. Related Sections:
   1. Refer to the General Conditions for general requirements, and technical specifications for specific testing requirements and methods.
   2. Section 013300 - Submittal Procedures.

1.2 REFERENCES

1.3 QUALIFICATIONS OF TESTING AGENCY
A. "Approved independent testing laboratory" shall mean an independent testing agency acceptable to the Owner and the Architect and possessing the professional qualifications and equipment to perform the specified tests and to evaluate and report the results.

1.4 QUALITY ASSURANCE
A. Comply with requirements of ASTM E329 and ASTM D3740.
B. Laboratory shall maintain a full-time registered Engineer on staff to review services.
C. Laboratory authorized to operate in State in which Project is located.
D. Testing equipment shall be calibrated at reasonable intervals with devices of an accuracy traceable to either NBS Standards or accepted values of natural physical constants.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 TESTING AND SPECIAL TESTING
A. Unless otherwise provided in the specifications, provide all materials, samples, mock-ups or assemblies for all tests specified in various sections of specifications, or as directed by the Architect, and pay shipping costs of such samples to laboratory or other testing location and facility.
   1. Unless specified otherwise, all tests shall be made by an approved independent testing laboratory and reports provided to Architect.
B. Tests shall be provided and accomplished in accordance with the standard used as the reference for the particular material or product, unless other test methods or criteria are specified.
C. In the absence of a referenced standard, tests shall be accomplished in accordance with applicable ASTM Standards or Test Methods, current at the date of the Contract Documents.
3.2 PAYMENT FOR TESTS
A. Unless noted otherwise, tests specified will be paid for by the Contractor. If tests are noted as being paid by the Owner, tests will be paid directly to the testing laboratory by the Owner.

B. The Owner will not pay for tests to determine if a proposed material will initially meet the specified requirements.

3.3 TESTS TO DEMONSTRATE QUALIFICATION
A. In addition to tests specified, should the Contractor propose a product, material, method or assembly that is of unknown or questionable quality to the Architect, the Architect may require and order suitable tests to establish a basis for acceptance or rejection.
   1. Such tests will be paid for by the Contractor, or by the Subcontractor requesting approval. "Standard" test reports on "similar" material will not be acceptable.

B. The Owner and Architect reserve the right to require certification or other proof that the material, assembly, equipment, system or other product furnished or proposed to be furnished, for this Project is in compliance with any test or standard called for.
   1. The certificate shall be signed by a representative of the independent testing laboratory.

C. Any tests required to qualify the Contractor or any workmen for any phase of the work, and any test of a method, system or equipment that may be required by specification or law to qualify the item for use, shall be made or taken without additional reimbursement.

D. If exploratory work is required to determine the cause of defects, the cost of such work shall be borne by the Contractor responsible for such work if the work is found, in the judgement of the Architect to be defective.
   1. If the Contractor responsible for the work is adjudged by the Architect to be not at fault, exploratory testing will be paid by the Owner.

3.4 INSPECTIONS
A. Should the specifications, Architect's instruction, laws, ordinances or any public authority require any work to be inspected or approved, give timely notice of its readiness for inspection and a reasonable date fixed for such inspection. If any work requiring inspection should be covered up without approval or consent of the approving agency, it must be uncovered for examination at Contractor's expense.

3.5 CERTIFICATES
A. Except for test reports provided and signed by approved independent testing laboratories, all certificates required by the specification shall be signed by an authorized official of the firm providing the certificate, with the signature notarized, when such certificates by the producer are acceptable to the Architect.

3.6 RETEST RESPONSIBILITY
A. Where results of required inspections, tests or similar prove unsatisfactory and do not indicate compliance of related work with requirements of the contract documents, then retests are responsibility of Contractor, regardless of whether original test was Contractor's responsibility.

B. Retesting of work revised or replaced by Contractor is Contractor's responsibility, where required tests were performed on original work.

END OF SECTION
SECTION 01 4533
STRUCTURAL TESTING AND SPECIAL INSPECTION

PART 1  GENERAL

1.01  INTENT AND CONDITIONS

A. Intent

1. Define and coordinate structural testing and special inspection services.

2. Provide a greater level of confidence that the specified work is constructed in compliance with the contract documents and the intent of applicable codes including Sections 110 and 1704 of the 2012 International Building Code (IBC) as adopted by the current Minnesota State Building Code.

3. Structural testing and special inspection services are intended to assist in determining probable compliance of the work with requirements specified. These services do not relieve the Contractor of responsibility for compliance with the requirements of the contract documents.

B. Conditions

1. If inspection of a fabricator's work is required, the Owner's representative may require testing and inspection of the work at the plant, before shipment. Owner and Architect reserve the right to reject material not complying with the Contract Documents.

2. Refer to individual technical specification sections for specific qualifications, inspections, tests, frequency and standards required. Testing and inspection shall be performed in accordance with the referenced standard for the specific material or procedure unless other criteria are specified. In the absence of a referenced standard, tests shall be performed in accordance with generally accepted industry standards.

3. Work shall be checked as it progresses. Failure to detect any defective work or materials shall not prevent later rejection if defective work or materials are discovered, nor shall it obligate Owner to accept such work.

4. Structural testing, special inspection, and periodic inspections by the Building Official do not preclude the normal field involvement and site observations by Architect or SER.

5. Structural testing, special inspection, and periodic inspections by the Building Official do not relieve the Contractor of any responsibility to complete the work in accordance with the approved drawings and specifications.

6. Testing agents and/or special inspectors may not waive or alter contract requirements, or approve or accept any portion of the work unless specifically authorized by the Architect or SER. They may not assume any duties of the Contractor, and they have no authority to stop or reject work.

1.02  RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications apply to this section.
1.03 DEFINITIONS
A. Testing: Evaluation of systems, primarily requiring physical manipulation and analysis of materials, in accordance with approved standards.
B. Inspection: Evaluation of systems, primarily requiring observation and judgment.
C. Structural Special Inspections: Structural special inspections include inspections of structural items required by the 2012 IBC Section 1704, as adopted by the 2015 Minnesota State Building Code, and other items, which in the professional judgment of the Structural Engineer of Record, are critical to the integrity of the building structure and are indicated to be performed under the requirements of this section. They do not include special inspections for non-structural items such as fireproofing, EIFS, and smoke control systems.
D. Structural Testing: Structural testing includes those tests of structural items required by the 2012 IBC, as adopted by the 2015 Minnesota State Building Code, or its referenced standards, and other tests, which in the professional judgment of the Structural Engineer of Record, are critical to the integrity of the building structure and are indicated to be performed under the requirements of this section.
E. Architect of Record: The prime consultant in charge of overall design and coordination of the project.
F. Structural Engineer of Record (SER): The licensed professional engineer in responsible charge of the structural design for the project.
G. Licensed Structural Engineer: A professional engineer with education and experience in the design of structures similar to this project licensed to practice in the State in which the Project is located.
H. Testing Agency (TA): The properly qualified firm performing testing services.
I. Special Inspector (SI): A properly qualified individual or firm performing special inspections.
J. Building Official: The officer or his duly authorized representative charged with the administration and enforcement of the building code for the project.

1.04 REFERENCES
A. ASTM C1077-13 – Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
B. ASTM C1093-12 - Practice for the Accreditation of Testing Agencies for Unit Masonry.
C. ASTM D3740-12a - Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

1.05 QUALIFICATIONS
A. Testing Agency: An approved independent testing agency acceptable to the Owner, Architect, and SER and meeting the following:
1. Authorized to operate in the State in which the project is located and experienced with the requirements and testing methods specified in the Contract Documents.

2. Meet applicable requirements of references stated in paragraph 1.4.

3. Have available testing equipment that is calibrated, at reasonable intervals, by devices of accuracy traceable to either the National Bureau of Standards, or to accepted values of natural physical constants.

4. Provide individuals performing tests and taking samples with appropriate certifications for work performed.

B. Special Inspector: Either an appropriately certified inspector or a civil/structural engineer performing under the direct supervision of a licensed structural engineer (as defined earlier in this section) and acceptable to the SER and Building Official. Unique special inspector requirements, for specific materials and systems, are noted in related technical specification sections.

1.06 RESPONSIBILITIES

A. Special Inspectors:

1. Inspect the work assigned for conformance with the building department approved plans, specifications, and applicable material and workmanship provisions of the code. Perform inspection in a timely manner to avoid delay of work.

2. Bring nonconforming items to the immediate attention of the contractor for correction. If not corrected within 24 hours or if inspector will not be on site the following day, bring to the attention of the SER by the end of the business day. If uncorrected after a reasonable period of time, bring to the attention of the Building Official, and to the Architect. Notify SER immediately if non-conforming items are enclosed, embedded, or obscured prior to verification of correction.

3. Submit inspection reports to the Building Official, Contractor, the Architect, the SER, and other designated persons in accordance with the structural testing and special inspection schedule.

4. Submit a final signed report stating whether the work requiring special inspection was, to the best of his/her knowledge, in conformance with the approved plans, specifications and the applicable workmanship provisions of the code.

5. Sign the structural testing and special inspection schedule in conjunction with other responsible parties.

6. Attend preconstruction meeting to review scope of special inspection.

B. Testing Agency:

1. Test the work assigned for conformance with the building department approved plans, specifications, and applicable material provisions of the documents. Perform tests in a timely manner to avoid delay of work.

2. Submit test reports to the Building Official, Contractor, the Architect, the SER, and other designated persons in accordance with the structural testing and special inspection schedule.
3. Sign the structural testing and special inspection schedule in conjunction with other responsible parties.

4. Attend a preconstruction meeting to review scope of structural testing.

C. Contractor:

1. Attend a preconstruction meeting to review scope of structural testing and special inspection.

2. Post or make available the structural testing and special inspection schedule within its office at the job site. Also, provide adequate notification to those parties designated on the schedule so they may properly prepare for and schedule their work.

3. Provide special inspectors access to the approved plans and specifications at the job site.

4. Review all reports issued by special inspectors.

5. Retain, at the job site, all reports submitted by the special inspectors for review on the Building Official's request.

6. Correct deficiencies identified in inspection or testing reports in a timely manner.

7. Provide safe access to the work requiring inspection or testing.

8. Provide labor and facilities to provide access to the work, to obtain, handle and deliver samples, to facilitate testing and inspection and for storage and curing of test samples.

9. Verify conformance of the work with specified construction tolerances.

10. Inspections by Building Official: Provide adequate notice for inspections performed by the building official, as required by IBC Section 109, the Minnesota State Building Code, and local ordinances.

11. Sign the structural testing and special inspection schedule in conjunction with other responsible parties prior to commencing construction.

D. Fabricator:

1. Submit a Certificate of Compliance to the Building Official, Special Inspector, and SER that the work was performed in accordance with the approved plans and specifications.

2. Sign the structural testing and special inspection schedule in conjunction with other responsible parties prior to commencing construction.

E. Owner:

1. Establish direct funding to provide for cost of structural testing and special inspection services.

2. Provide special inspector with approved plans, specifications and approved shop drawings.

3. Provide special inspectors and testing agencies with full access to the site at all times.
4. Sign the Structural testing and special inspection schedule in conjunction with other responsible parties.

1.07 PAYMENT
A. Owner or Architect/SER, acting as the Owner's agent, will employ and pay for services of the special inspectors and testing agency to perform required structural testing and special inspection.
B. Unless noted otherwise, the Contractor shall provide and pay for all materials, samples, mock-ups, and assemblies required for testing and inspection and shall pay for shipping costs related to delivery of such items. Testing agency will pay for shipping costs of samples transported from site to lab.
C. If items requiring testing or inspection are enclosed, embedded or obscured prior to testing or inspection or if such items are placed without tests or inspections, the Contractor shall pay for the costs of any exploratory work deemed necessary by the Architect/SER to verify compliance with the Contract Documents.
D. Contractor shall pay for the costs of any retests or re-inspections caused by work that does not comply with the Contract Documents based on initial tests or inspections, or work that is later revised or replaced by the Contractor. This does not include revisions requested by the Owner.

1.08 INSPECTION NOTICE
A. Provide minimum of 24 hours notice for all items requiring testing or inspection. Items requiring testing and inspection services prior to or during placement shall not be placed until testing and inspection services are available. Items requiring testing and inspection services after placement shall not be enclosed or obscured until testing and inspection services are performed.

1.09 REPORTS
A. Testing agency and special inspectors shall submit reports for structural testing and special inspection in a timely manner to the Contractor, Building Official, SER, and Architect of Record. Provide reports of daily activities to the SER and Contractor. Submit reports to the Contractor on a daily basis and to the SER on a daily or weekly basis. Provide summary reports to the Building Official and Architect on a monthly basis unless they request otherwise.
B. Provide reports for ongoing work, containing the following information:
   1. Date issued.
   2. Project title and number.
   3. Firm name and address.
   4. Name and signature of tester or inspector.
   5. Date and time of sampling, test, or inspection.
   6. Identification of product and specification section.
   7. Location in project, including elevations, grid location and detail.
   8. Type of test or inspection.
9. Whether test specimens, test results or observations indicate compliance with Contract Documents. Specifically state any discrepancies

10. Types and locations of discrepancies found in work

11. Work required performed to correct discrepancies and work performed to correct previously noted discrepancies. Discrepancies corrected during an inspection need not be reported

12. Submit certified final special inspection report stating that, to the best of the special inspector's knowledge, the work requiring special inspection conformed to the Construction Documents.

1.10 FREQUENCY OF TESTING AND INSPECTION
A. For detailed requirements, see individual technical specification sections and the structural testing and special inspection schedule.

1.11 PROTECTION AND REPAIR
A. Upon completion of testing, sample-taking, or inspection, the Contractor shall repair damaged work and restore substrates and finishes to eliminate deficiencies, including deficiencies in the visual qualities of exposed surfaces, as judged solely by the Architect/SER. Protect work exposed by or for testing and/or inspection and protect repaired work. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for testing and/or inspection.

1.12 TESTS TO DEMONSTRATE QUALIFICATION
A. Any tests required to qualify the Contractor or the workers for any phase of the work, shall be performed at no additional cost to the Owner.

B. If the Contractor proposes a product material, method, or other system that has not been pre-qualified, the Architect/SER may require applicable tests to establish a basis for acceptance or rejection. The Contractor shall pay for these tests.

C. The Architect/Engineer of Record reserves the right to require certification or other proof that the system proposed is in compliance with specified tests, criteria or standards. A representative of an independent testing agency shall sign the certificate.

1.13 STRUCTURAL TESTING AND SPECIAL INSPECTION SCHEDULE
A. The parties involved shall complete and sign the structural testing and special inspection schedule. Schedule to be complete at time of permit issuance.

B. The completed schedule is an element of the construction documents and after permit issuance, becomes part of the building department approved plans and specifications.
Structural Testing and Special Inspection
Statement of Special Inspections

Project Name: North Regional Library Refurbishment

Location: 1315 Lowry Ave. N., Minneapolis, MN 55411

Owner: Hennepin County

This Statement of Special Inspections is submitted as a condition for permit issuance in accordance with the Special Inspection and Structural Testing requirements of the 2012 International Building Code as adopted by the current Minnesota State Building Code. It includes a schedule of Special Inspection services applicable to this project and the identity of agencies to be retained for conducting these inspections and tests. This Statement of Special Inspections encompasses the following disciplines:

- Structural
- Architectural
- Other:

The Special Inspector shall keep records of all inspections and shall furnish inspection reports to the Building Official, the Architect and Structural Engineer of Record. Discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official, the Architect and SER. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted to the Building Official the Architect and SER.

A Final Report of Special Inspections documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

ACKNOWLEDGEMENTS

Each appropriate representative shall sign below:

Owner: ___________________________ Firm: Hennepin County ________________ Date: ________________
Contractor: ___________________________ Firm: ___________________________ Date: ________________
Architect: ___________________________ Firm: Bentz/Thompson/Rietow ________________ Date: ________________
SER: ___________________________ Firm: BKBM Engineers ________________ Date: ________________
SI-S: ___________________________ Firm: ___________________________ Date: ________________
SI-T: ___________________________ Firm: ___________________________ Date: ________________
TA: ___________________________ Firm: ___________________________ Date: ________________
F: ___________________________ Firm: ___________________________ Date: ________________

If requested by engineer/architect of record or building official, the individual names of all prospective special inspectors and the work they intend to observe shall be identified.

Legend: SER = Structural Engineer of Record SI-T = Special Inspector - Technical TA = Testing Agency
        SI-S = Special Inspector - Structural F = Fabricator

Accepted for the Building Department By ___________________________ Date ________________
# Structural Testing and Special Inspection

**Program Summary Schedule**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>North Regional Library Refurbishment</th>
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<tbody>
<tr>
<td>Location</td>
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<tr>
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<td>_________________________________</td>
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<td>Description (3)</td>
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<td>Concrete Formwork</td>
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<td>03 1510</td>
<td>Post-Installed Anchors</td>
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<tr>
<td>03 2000</td>
<td>Concrete Reinforcement</td>
</tr>
<tr>
<td>03 3000</td>
<td>Cast-in-Place Concrete Tests</td>
</tr>
<tr>
<td>03 3000</td>
<td>Cast-in-Place Concrete Inspections</td>
</tr>
<tr>
<td>05 1200</td>
<td>Structural Metal Framing</td>
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<tr>
<td>05 5000</td>
<td>Stair and Railing Welding</td>
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<td>31 0000</td>
<td>Earthwork</td>
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<td>Type of Inspector (4)</td>
<td>Report Frequency (5)</td>
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<td>Per test/inspection</td>
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<td>Per test/inspection</td>
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<td>Per test/inspection</td>
</tr>
<tr>
<td>SI-T</td>
<td>Weekly</td>
</tr>
</tbody>
</table>

**Notes:**
This schedule shall be filled out and included in the Structural Testing and Special Inspection Program.

1. Permit No. to be provided by the Building Official.
2. Referenced to the specific technical scope section in the program.
3. Use descriptions per IBC Section 1704, as adopted by Minnesota State Building Code.
5. Weekly, monthly, per test/inspection, per floor, etc.
6. Firm contracted to perform services.

END OF SECTION
PART 1 – GENERAL

1.01 REQUIREMENTS INCLUDED

A. Construction Lighting and Power
B. Construction Heating and Ventilation
C. Telephone, Facsimile and Internet Services
D. Water
E. Sanitary Facilities
F. Barriers
G. Security
H. Protection of Existing and Installed Work
I. Fire Extinguishers and Safety Equipment
J. Site and Temporary Access
K. Deliveries
L. Cleaning During Construction
M. Public Areas Cleaning
N. Noise Producing Activities
O. Interruptions of Power
P. Temporary Environmental Controls
Q. Removal

1.02 RELATED REQUIREMENTS

A. Section 01 11 00 – Summary of Work: Contractor use of premises.
B. Section 01 74 00 – Cleaning: Clean-up during Work and final cleaning

1.03 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction.
C. Electrical Service: Comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).

1.04 CONSTRUCTION LIGHTING AND POWER

A. The Prime Contractor shall furnish, install and maintain construction lighting and power systems for the use of the Prime Contractor and all Subcontractors. The Owner will pay the costs of electrical energy and demand charges necessary for the Work of the Project. Supplemental electrical requirements shall be provided and maintained by the Prime Contractor.
B. As soon as possible after commencement of the Work, the Prime Contractor shall furnish and install temporary electrical services. The temporary electrical services may originate from existing power systems within the existing facility. Coordinate the location of all necessary temporary connections, temporary feeders and related work with the Owner.

C. Each Subcontractor shall furnish their own extension cords, and Subcontractors requiring supplemental lights shall furnish their own portable lights.

D. If any Subcontractor requires voltage higher than 208 volts, the Electrical Subcontractor shall provide the necessary temporary wiring, and the Subcontractor requiring such Work shall pay the cost thereof.

E. The temporary light and power system shall not be used for temporary heating, electric welders, hoisting or temporary elevators:

F. If any Subcontractor requires 3-phase power, power for tools larger than the maximum loads specified above or power for heating, electric welders, hoisting or temporary elevators, they shall make arrangements for additional separate temporary service capacity as required, for the necessary additional electrical distribution systems and shall pay the energy and all related additional costs thereafter.

G. Remove the temporary light and power systems when no longer required.

H. Permanent Electrical System – The Owner will assume the responsibility for the permanent electrical systems on the date of partial occupancy or the date of Substantial Completion of the Project, whichever is sooner.

I. All temporary lighting and power systems shall meet OSHA requirements.

1.05 CONSTRUCTION VENTILATION

A. Construction Ventilation - The Prime Contractor shall ventilate as necessary to eliminate excessive dust, humidity and condensation in all Work areas. Power ventilation using temporary equipment shall be used as necessary.

C. Warranties – Use of the permanent heating, ventilation and air handling equipment prior to Substantial Completion of the Project Work shall not change the terms of the warranty required by the General Conditions and special warranties, if any, specified elsewhere in the Contract Documents and the correction period required by the General Conditions.

D. Permanent Heat and Ventilation – The Owner will assume all responsibility and begin to pay all costs for heating and ventilating the Project on the date of partial occupancy or the date of Substantial Completion of the Project, whichever occurs sooner.

1.06 TELEPHONE, FACSIMILE AND INTERNET SERVICES

A. The Contractor shall provide, pay for and maintain separate field office telephone, cellular telephones and facsimile machine services in their field office for their own use, for the use of their Subcontractors and for use by representatives of the Architect and the Owner. Maintain field office telephone, cellular telephone and facsimile machine services until the final Substantial Completion of the Project.

1.07 WATER

A. Drinking Water – The Contractor may use the existing drinking fountains as directed by the Owner.

1.08 SANITARY FACILITIES
A. Contractor personnel may use the Owner’s existing building toilets as directed by the Owner;

1.09 BARRIERS

A. The Prime Contractor shall provide barriers as required to prevent public entry into construction areas.

B. The Prime Contractor shall provide temporary partitions in all interior spaces, either metal stud or wood framed with plywood or gypsum board sheathing, that are dust proof with poly barriers extending to the structural deck, adjacent walls and floor slab, to prevent public entry within the Construction Zone and to prevent migration of dust and other construction debris outside the Construction Zone.

a. All locations of temporary partitions are to be coordinated with the Owner to maintain public access to all facilities outside the Construction Zone used by the public and to maintain code required egress from the facilities.

b. The Contractor is to coordinate with the Owner access into the Construction Zone to authorized facilities personnel to perform maintenance tasks as required on existing systems operating during the Construction period.

C. The Contractor shall move and/or remove the barriers as required by the progress of the Work.

1.10 SECURITY

A. Project security requirements within and around all Project Work areas shall be the responsibility of the Contractor. The Prime Contractor shall take whatever measures are necessary to maintain security at all Work areas at all times.

B. The Prime Contractor shall secure all Work construction, staging and storage areas adequately to prevent entry by vandals, particularly all scaffolds. The purpose of all security measures shall be to avoid opportunities for harm to the Work and to entry by unauthorized persons. Provide fences to secure all Work areas as required.

C. The Prime Contractor and each Subcontractor shall bear full responsibility for protecting equipment, materials, tools and completed Work from damage, loss and vandalism at all times.

1.11 PROTECTION OF EXISTING AND INSTALLED WORK

A. Provide temporary protection for existing to remain conditions. Control traffic in immediate area to minimize damage.

B. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings. Protect finished floors and stairs from traffic, movement of heavy objects and storage.

C. Prohibit traffic and storage on all roof surfaces and on new pavements, lawn and landscaped areas.

D. The Prime Contractor shall protect excavations, trenches, other temporary work, the building and other Work of the Project from damage from water, including ground water, rain water, back-up of sewers and drains, and ice and snow. Keep excavations, trenches and low areas free from water during the progress of the Work, and provide temporary enclosures, pumps and equipment and do all grading, pumping, bailing or other Work necessary to insure this protection.

E. The Prime Contractor shall provide protection against wind, storms, frost, rain, snow, heat and cold to avoid injury to material in transit, stored material and Work in place.

F. The Prime Contractor shall protect completed roofs throughout the course of construction. Provide temporary construction walkways, runways and work platforms at all affected roof areas. Protection shall consist of ¾” plywood on 1” rigid insulation, ballasted, in all areas as directed by the Architect or the Owner.
1.12 FIRE EXTINGUISHERS AND SAFETY EQUIPMENT

A. Provide hand-carried, portable UL-rated class “A” fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable UL-rated class “ABC” dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposure.

B. Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.

C. The Prime Contractor shall provide 25 new hard hats for use by the Owner and Owner’s visitors during the Project. Hard hats shall be adjustable ratchet, head-band type, similar to Jackson Co.

1.13 SITE AND TEMPORARY ACCESS

A. Contractor’s and Subcontractors’ access to the Project site and arrangements for temporary access for specific construction requirements shall be coordinated by the Prime Contractor with the Owner.

1.14 DELIVERIES

A. The Prime Contractor and all Subcontractors receiving deliveries at the site shall request a minimum twenty-four (24) hour notice of delivery from suppliers. The Prime Contractor and all Subcontractors receiving deliveries shall ensure that construction personnel are at the site to receive deliveries, unload, handle, properly store and protect same.

B. Any Subcontractor or supplier not giving proper notice shall reimburse the Prime Contractor at the site or be back-charged accordingly for unloading, handling and storage of said materials.

C. Delivery of materials shall not be made to the job site before progress of the job and/or the Construction Schedule calls for it, unless approved by the Prime Contractor.

D. All materials for the Project Work shall be accepted and received by the Prime Contractor, or applicable Subcontractors. The Owner will not accept or unload any deliveries. Use of the Owner’s equipment for unloading is not allowed.

E. All mail, parcels, packages and similar deliveries shall not be addressed to the Owner, but only to the Prime Contractor or others, at separate addresses.

1.15 CLEANING DURING CONSTRUCTION

A. Control accumulation of waste materials and rubbish; regularly dispose of off-site. Also see Section 01 74 00 for additional requirements.

B. Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.

1.16 PUBLIC AREAS CLEANING

A. The Contractor is responsible for daily cleaning of any dust, dirt or other construction waste in all interior spaces immediately outside the Construction Zone. The Contractor will maintain its main access to the Construction Zone for all its Employees and Subcontractors directly from the exterior and not through adjacent spaces within campus buildings outside the Construction Zone.

1.17 INTERRUPTIONS IN POWER

A. The Owner’s intent is to maintain the operations of the hot and chilled water plant and the main electrical service as much as possible throughout Construction. In events where service must be
unavoidably interrupted during Construction, the interruption must first be coordinated with the Owner before said service is shut off.

a. Interruptions effecting electrical lines lasting over a day in duration will need to coordinated with the Owner during the formation of the initial Construction critical path schedule and are to be documented as critical path events. The Contractor is to keep the Owner informed by updates in the critical path schedule of any changes in the scheduling of these interruptions.

b. Other interruptions limited in their duration and areas affected are to be coordinated with the Owner to provide sufficient time for the Owner to notify effected staff and reschedule activities as required. The Owner may chose to postpone the interruption at their discretion when the Owner is not given sufficient time to make reasonable accommodations.

1.18 TEMPORARY ENVIRONMENTAL CONTROLS

A. The Contractor and all Subcontractors shall conform to the requirements of all authorities having jurisdiction (AHJ) with regard to environmental protection including erosion, debris pollution, dust and air pollution, water and noise.

1.19 REMOVAL

A. Remove temporary materials, equipment, services, and construction prior to the Substantial Completion inspection.

B. Clean and repair damage caused by installation or use of temporary facilities.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 IAQ DESIGN DETERMINANTS

A. The building is programmed and designed with smoking prohibited in the building during construction and occupancy.

B. Smoking is not permitted. The campus in its entirety is tobacco free including e-cigarettes

C. The building is programmed and designed with low-emitting materials specified and scheduled with emission limits required for materials used in the construction.

1.3 INDOOR AIR QUALITY CONTROL PROCEDURES

A. The Contractor shall develop, implement and monitor a construction phase indoor air quality ("IAQ") plan (the "IAQ Plan") to limit the amount of IAQ pollutants in the Project and the Owner's existing facility resulting from construction operations. The amount of any pollutant that could contribute to degrading the IAQ (IAQ pollutants) in the Project and the Owner's existing facility from construction operations shall not exceed the more stringent of (a) the maximum levels allowable or deemed appropriate by applicable federal, state or local codes, laws, ordinances, regulations, rules or statutes (collectively, the "Laws") or (b) the maximum levels permitted by the Owner as specified. At a minimum, the IAQ Plan shall comply with all applicable Laws, SMACNA IAQ Guidelines for Occupied Buildings Under Construction, and advanced levels of SMACNA Duct Cleanliness for New Construction Guidelines, and NADCA General Specifications for the Cleaning of Commercial HVAC Systems (National Air Duct Cleaners Association).

B. The Contractor shall submit to the Owner for approval a project-specific IAQ Plan outlining the specific means and methods for achieving these requirements and shall not commence any construction operations prior to receiving the Owner's written approval of the IAQ Plan.

C. The IAQ Plan shall specify, among other things, the means and methods by which the Contractor shall control biological, particulate, vaporous, fume and gaseous pollutants including, but not limited to, source control, ventilation control, containment control, filtration control and occupant exposure control. Plan shall be organized by topic to address the required subjects:

   a. Provide Inventory of absorptive materials to be used with pre-installation storage procedures and post-installation procedures to prevent moisture damage.

2. Replacing Filtration Media.
   a. Identify filter location, type and MERV rating.
   b. Provide construction ventilation plan. Indicate whether modification and use of Owner’s existing ventilation system will be used. If used, identify means to isolate construction from occupancy equipment and distribution to prevent cross-over contamination.

3. Temporary Construction Ventilation.
   a. Provide a detailed narrative describing the project’s temporary construction ventilation.
   b. Temporary Construction ventilation narrative shall include the following requirements:
      1) Maintain sufficient temporary ventilation of areas where materials are being used that emit VOCs.
      2) Maintain ventilation continuously during installation, and until emissions dissipate after installation. If continuous ventilation is not possible via building's HVAC system(s) then ventilation shall be supplied via open windows and temporary fans, sufficient to provide no less than three air changes per hour.
      3) Period after installation shall be sufficient to dissipate odors and elevated concentrations of VOCs. Where no specific period is stated in the Specifications, a time period of 72 hours shall be used.
      4) Ventilate areas directly to outside. Ventilation to other enclosed areas is not acceptable.

4. Protecting HVAC System.
a. Provide a detailed narrative describing the mechanisms by which HVAC system equipment and distribution systems (ducts and pipes) will be protected from accumulating dirt and debris during construction.
b. Temporary Construction ventilation narrative shall include the following requirements:
   1) During dust-producing activities (e.g., drywall installation and finishing), turn ventilation system off and protect openings in supply and return HVAC system from dust infiltration.
   2) Provide temporary ventilation as required.
   3) Seal ducts during transportation, delivery, and construction to prevent accumulation of construction dust and construction debris inside ducts.

5. Offsite Product Preconditioning.
a. Provide a detailed narrative describing the project’s means of offsite product preconditioning.
b. Offsite product conditioning shall include the following requirements:
   1) All products which have odors and significant VOC emissions shall be preconditioned off-site prior to delivery to the Project site. Allow products to off-gas in a dry, well-ventilated space for 14 calendar days to allow for reasonable dissipation of odors and emissions.
   2) Condition products without containers and packaging to maximize off-gassing of VOCs.
   3) Condition products in ventilated warehouse or other building.

a. Provide a detailed narrative describing the project’s process for identifying (regular inspections), removing, and disposing of moisture damaged materials and replacement procedures.
b. Removing moisture damaged materials narrative shall include the following requirements:
   1) Materials with evidence of moisture damage, including stains, are not acceptable. This includes both stored and installed materials. Immediately remove all such materials from the site and properly dispose.
   2) Take special care to prevent accumulation of moisture on installed materials and within packaging during delivery, storage, and handling to prevent development of molds and mildew on packaging and on products.
   3) Immediately remove from site and properly dispose of materials showing signs of mold and/or signs of mildew, including materials with moisture stains.
   4) Replace moldy materials with new, undamaged materials.

a. Provide a detailed narrative describing the project’s means to protect porous materials.
b. Where odorous and/or high VOC emitting products are applied on-site, apply prior to installation of porous and fibrous materials. Where this is not possible, protect porous materials with polyethylene vapor retarders.
c. Protecting fibrous materials narrative shall include the following requirements:
   1) Inventory of all VOC-emitting or odor-emitting materials and where they are to be used, by building location.
   2) Inventory of all porous and fibrous materials and where they are to be used, by building location.
   3) Highlight locations where both categories of materials are to be used in the same location.
   4) Describe means of preventing the absorption of VOCs and/or odors by the porous and fibrous materials in each of these locations.

a. Provide a detailed narrative describing the project’s pre-occupancy flush-out procedures.
b. Building flush-out shall include the following requirement:
   1) After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu. ft. of outdoor air per square feet of floor area while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%.
   2) Replacement of filters after building flush-out. MERV 9 pre-filters and MERV 13 filters as Owner's Design Standards require.

D. The Contractor shall coordinate the IAQ Plan with the Owner's on-going operations and shall cooperate with the Owner to minimize any disturbances to the Owner's on-going operations caused by the Contractor's implementation of the IAQ Plan.

E. The Contractor shall provide the Owner with monthly written results of periodic monitoring confirming that the amount of air-borne pollutants resulting from construction operations are below the maximum levels required by this Section. If the amount of any IAQ pollutant exceeds the maximum level required by this
Section at any time during construction, the Contractor shall immediately notify the Owner thereof in writing and shall immediately take all actions necessary to reduce the amount of such air-borne pollutant below the maximum level.

F. End of Project Summary;
   1. Provide a brief summary of the project’s means of protecting stored absorptive materials, include captioned photos to highlight the Construction Air Quality Management Plan practices.
   2. Provide documentation of the project’s replacement of all filter media in tabular format by location, type and date replaced.
   3. Provide a brief summary of the project’s temporary construction ventilation, include captioned photos to highlight the Construction Air Quality Management Plan practice.
   4. At the end of construction, include a brief summary of the project’s means of protecting the HVAC system, include captioned photos to highlight the Construction Air Quality Management Plan practices.
   5. Provide a brief summary of the project’s offsite product preconditioning; include descriptions of offsite products, means of preconditioning and locations, captioned photos to highlight the Construction Air Quality Management Plan practices.
   6. Provide a brief summary of the project’s moisture damaged materials, replacement occurrences, preventive and corrective procedures, include captioned photos to highlight the Construction Air Quality Management Plan practices.
   7. Provide a brief summary of the project’s means of protecting porous materials, include captioned photos to highlight the Construction Air Quality Management Plan practices.
   8. Provide a brief summary of the building flush-out period, include data regarding temperature, airflow, and duration of flush-out.

G. The Project shall not be occupied by the Owner, and final payment shall not be due to the Contractor, until all aspects of the IAQ Plan have been implemented and the Contractor has certified to the Owner in writing that all building materials and systems that affect IAQ are functioning properly and that the amount of air-borne pollutants in the Project and the Owner’s existing facility are below the maximum levels required by this Section.

1.4 SUBMITTALS

A. Submit product data and calculations to document the following:
   1. Submit the following:
      a. Submit a copy of the IAQ Plan.
      b. Submit proposed air handling equipment to be used.
      c. Submit a list of temporary filtration media, indicating respective manufacturer, model number, MERV rating, and filter application. Furnish written confirmation that each type of temporary filtration media was replaced prior to final occupancy.
      d. Submit a description of special conditions or non-standard approaches to be implemented.
   2. Submit the following:
      a. The proposed approach to be employed on the Project (e.g., pre-occupancy flush-out, flush-out with early occupancy, IAQ testing, etc.).
      b. A copy of the Project’s IAQ testing report, as applicable.
      c. A description of the Project’s specific flush-out procedures and/or IAQ testing process and results.
   3. Submit the following:
      a. End of Project Summary.

PART 2 - PRODUCTS

2.1 MATERIAL EMISSIONS AND POLLUTANT CONTROL

A. All newly installed interior materials shall be certified to comply with the most current Indoor Air Quality portion of California Section 01350 standard. Selection of a product listed in one of the approved databases below is sufficient to comply.
   1. Approved databases of materials that are recognized as substantially compliant with the most current Indoor Air Quality portion of California Section 01350 standard:
      a. California High Performance Schools (CHPS) Low Emitting Materials (LEM) Table
      b. Carpet and Rug Institute (CRI) Green Label Plus Certification (for Adhesives)
      c. Carpet and Rug Institute (CRI) Green Label Plus Certification (for Carpet)
      d. Scientific Certification Systems (SCS) Gold Indoor Advantage Certification
      e. Scientific Certification Systems (SCS) FloorScore™ Certification
      f. GREENGUARD Product Emission Standard For Children & Schools™
B. Composite wood products shall have formaldehyde emission rates not greater than the following when tested according to ASTM D 6007 or ASTM E 1333.
   1. Hardwood Plywood: 0.05 ppm.
   2. Particleboard: 0.09 ppm.
   3. Medium-Density Fiberboard More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
   4. Medium-Density Fiberboard 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

C. Adhesives and Sealants: Not less than 100 percent of field-applied adhesives and sealants that are inside the weatherproofing system shall comply with either of first two subparagraphs below:
   1. VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 micrograms/cu. m or 13.5 ppb, whichever is less.
   2. VOC content shall not exceed limits of authorities having jurisdiction and the following:
      a. Carpet Adhesives: 50 g/L.
      b. Carpet Pad Adhesives: 50 g/L.
      c. Wood Flooring Adhesive: 100 g/L.
      d. Rubber Floor Adhesives: 60 g/L.
      e. Subfloor Adhesives: 50 g/L.
      f. Ceramic Tile Adhesives: 65 g/L.
      g. VCT and Asphalt Tile Adhesives: 50 g/L.
      h. Gypsum Board and Panel Adhesives: 50 g/L.
      i. Cove Base Adhesives: 50 g/L.
      j. Multipurpose Construction Adhesives: 70 g/L.
      k. Structural Glazing Adhesives: 100 g/L.
      l. Single-Ply Roof Membrane Adhesive: 250 g/L.
      m. Architectural Sealants: 250 g/L.
      n. Sealant Primers for Nonporous Substrates: 250 g/L.
      o. Sealant Primers for Porous Substrates: 775 g/L.
      p. Modified Bituminous Sealant Primers: 500 g/L.
      q. Other Sealant Primers: 750 g/L.
      r. CPVC Welding Compounds: 490 g/L.
      s. PVC Welding Compounds: 510 g/L.
      t. ABS Welding Compounds: 325 g/L.
      u. Plastic Cement Welding Compounds: 250 g/L.
      v. Adhesive Primer for Plastic: 550 g/L.
      w. Contact Adhesive: 80 g/L.
      x. Special-Purpose Contact Adhesives (Contact Adhesives That Are Used to Bond Melamine-Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
      y. Structural Wood Member Adhesives: 140 g/L.

D. Paints and Coatings: Not less than 100 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:
   1. VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 micrograms/cu. m or 13.5 ppb, whichever is less.
   2. VOC content shall not exceed limits of authorities having jurisdiction and the following:
      a. Flat Coatings: 50 g/L.
      b. Nonflat Coatings: 100 g/L.
      c. Nonflat - High Gloss Coatings: 150 g/L.
      d. Basement Special Coatings: 400 g/L.
      e. Bond Breakers: 350 g/L.
      f. Concrete Curing Compounds: 350 g/L.
      g. Concrete/Masonry Sealers: 100 g/L.
      h. Dry-Fog Coatings: 150 g/L.
      i. Faux Finishing Coatings: 350 g/L.
      j. Fire-Resistive Coatings: 350 g/L.
      k. Floor Coatings: 100 g/L.
      l. Form-Release Compounds: 250 g/L.
      m. Graphic Arts Coatings (Sign Paints): 500 g/L.
      n. High-Temperature Coatings: 420 g/L.
      o. Industrial Maintenance Coatings: 250 g/L.
p. Low Solids Coatings: 120 g/L.
q. Magnesite Cement Coatings: 450 g/L.
r. Mastic Texture Coatings: 100 g/L.
s. Metallic Pigmented Coatings: 500 g/L.
t. Multi-Color Coatings: 250 g/L.
u. Pretreatment Wash Primers: 420 g/L.
w. Reactive Penetrating Sealers: 350 g/L.
x. Recycled Coatings: 250 g/L.
y. Rust-Preventive Coatings: 250 g/L.
z. Shellacs, Clear: 730 g/L.
aa. Shellacs, Pigmented: 550 g/L.
bb. Stains: 250 g/L.
cc. Swimming Pool Coatings: 340 g/L.
dd. Tub and Tile Refinish Coatings: 420 g/L.
e. Waterproof Membranes: 250 g/L.
f. Wood Coatings: 275 g/L.
gg. Wood Preservatives: 350 g/L.
hh. Zinc-Rich Primers: 340 g/L.

E. Flooring: All flooring materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 micrograms/cu. m or 13.5 ppb, whichever is less. Where postmanufactured coatings or applications have not been applied, concrete; ceramic and concrete tile; clay and concrete pavers; metal; and organic-free, mineral-based flooring shall be deemed to comply with this requirement.

F. Acoustical Ceilings: All acoustic ceilings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 micrograms/cu. m or 13.5 ppb, whichever is less.

G. Wall Systems: All wall systems shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 micrograms/cu. m or 13.5 ppb, whichever is less. Where postmanufactured coatings or applications have not been applied, concrete, concrete masonry, clay masonry, gypsum plaster, ceramic and concrete tile, metal, and organic-free, mineral-based materials shall be deemed to comply with this requirement.

H. Insulation: All insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 micrograms/cu. m or 13.5 ppb, whichever is less, except for insulation manufactured without formaldehyde.

I. Remove CFC-based refrigerants from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant as described in HVAC Sections.

J. Total VOC Limit: Not less than 50 percent of adhesives, sealants, paints, coatings, flooring, acoustical ceilings, wall systems, and insulation shall have a total VOC emission rate of not more than 500 micrograms/cu. m when determined according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 CONSTRUCTION IAQ MANAGEMENT

A. Contractor shall implement the approved IAQ Plan.

B. Air-Quality Testing: Engage testing agency to perform the following:
1. Conduct baseline IAQ testing, periodically during construction, and after construction ends and prior to occupancy, using testing protocols in accordance with ASTM D 5197, ASTM D 5466,
ASTM D 6196, ASTM D 6345, and ISO 7708. The number of sampling points shall not be less than one per 25,000 sq. ft. (2300 sq. m) or for each contiguous floor area.

2. Concentrations of the following shall not exceed:
   a. Particulates (PM2.5): 35 micrograms/cu. m. (24 h)
   b. Particulates (PM10): 150 micrograms/cu. m. (24 h)
   c. Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
   d. 1, 1, 1-Trichloroethane: 1000 micrograms/cu. m.
   e. 1, 3-Butadiene: 20 micrograms/cu. m.
   f. 1, 4-Dichlorobenzene: 800 micrograms/cu. m.
   g. 1, 4-Dioxane: 3000 micrograms/cu. m.
   h. 2-Propanol: 7000 micrograms/cu. m.
   i. Acetaldehyde: 140 micrograms/cu. m.
   j. Acrylonitrile: 5 micrograms/cu. m.
   k. Benzene: 60 micrograms/cu. m.
   l. t-Butyl Methyl Ether: 8000 micrograms/cu. m.
   m. Carbon Disulfide: 800 micrograms/cu. m.
   n. Carbon Tetrachloride: 40 micrograms/cu. m.
   o. Chlorobenzene: 1000 micrograms/cu. m.
   p. Chloroform: 300 micrograms/cu. m.
   q. Dichloromethane: 400 micrograms/cu. m.
   r. Ethylbenzene: 2000 micrograms/cu. m.
   s. Ethylene Glycol: 400 micrograms/cu. m.
   t. Formaldehyde: 27 micrograms/cu. m.
   u. n-Hexane: 7000 micrograms/cu. m.
   v. Naphthalene: 9 micrograms/cu. m.
   w. Phenol: 200 micrograms/cu. m.
   x. Styrene: 900 micrograms/cu. m.
   y. Tetrachloroethane: 35 micrograms/cu. m.
   z. Toluene: 300 micrograms/cu. m.
   aa. Trichloroethane: 600 micrograms/cu. m.
   bb. Xylene Isomers: 700 micrograms/cu. m.
   cc. Total Volatile Organic Compounds: 500 micrograms/cu. m.

3. Where carpets and fabrics with styrene butadiene rubber latex backing are installed, concentrations of the following shall not exceed:
   a. 1-Methyl-2-Pyrrolidinone: 160 micrograms/cu. m.
   b. 2-Ethylhexanoic Acid: 25 micrograms/cu. m.
   c. 4-Phenylcyclohexene (4-PH): 2.5 micrograms/cu. m.
   d. Caprolactam: 100 micrograms/cu. m.
   e. Nonanal: 13 micrograms/cu. m.
   f. Octanal: 7.2 micrograms/cu. m.

4. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.

5. If any maximum concentration limit is exceeded and not mitigated and successfully retested, the building shall be flushed out for 14 days with air-handling units at maximum outside air while maintaining a temperature of at least 60 deg F (15.6 deg C) and a relative humidity of not more than 60 percent.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section includes:
   1. Methods and procedures to protect building occupants and surrounding area from excessive noise associated with construction work, and are referred to as the Noise Control Policy.

1.2 QUALITY ASSURANCE
A. Enforcement:
   1. Monitor noise levels through measurements to establish levels in excess of 85 dBA at 50 feet, and implementing additional mitigation procedures based on recommendations of acoustical consultant.

1.3 SCHEDULING
A. Schedule construction work generating disruptive levels of noise in advance, and set times as required and determined acceptable by Owner. Very early morning work and/or evening and weekend work may be required in extremely sensitive inhabited or occupied spaces. See 01 11 00 Summary of Work for building hours.

PART 2 PRODUCTS

2.1 CONSTRUCTION NOISE ASSESSMENT
A. Construction Noise levels at a distance of 50 feet for each phase of construction are shown below. Data are based on data for similar construction activities and published data.

PART 3 EXECUTION

3.1 MITIGATION
A. Attempt to implement the following construction noise mitigation measures on this Project:
   1. Erect barriers around noise generating operations.
   2. Turn off engines and compressors when not in operation; no idling.
   3. Define truck routes to confine noisy trucks to streets that currently have the heaviest traffic. Develop a truck staging area away from acoustically sensitive areas.
   4. Pre-cut metal decks and metal studs off site to minimize on-site sawing.
   5. Retain an acoustical consultant to provide assistance with developing additional noise attenuation techniques where needed.
   6. Avoid hammer drilling; use coring bits, instead. Avoid using power-actuated fasteners; use concrete screws, instead. Avoid sand blasting.
   7. Avoid sheet metal debris chutes; use plastic chutes.

B. Contractor is responsible for site supervision of potential sources of noise (e.g., material delivery, shouting, debris box pick-up and delivery) for all trades. Maintain awareness among trades of noise sensitivity of Project.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Provide protection of the environment during the construction of this project to reduce soil erosion and siltation to meet all local, state and federal standards.
C. Erosion and sediment control; as indicated on the Drawings, specified herein; including, but not limited to;
   1. Erosion Control Blankets
   2. Inlet Sediment Prevention Devices
   3. Temporary Seed
   4. Rock Construction Entrance
   5. Straw Mulch
   6. Straw Logs (Bio Logs)
   7. Temporary Sediment Traps
   8. Water Course Protection
D. Prevention of erosion due to construction activities.
E. Prevention of sedimentation of waterways, open drainage ways, and storm sewers due to construction activities.
F. Restoration of areas eroded due to insufficient preventive measures.
G. Maintain, replace, and remove all erosion control devices once vegetation has been established and all areas have been paved.
H. Compensation to Owner/Governing agencies for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 RELATED SECTIONS

A. Section 02 4113 - Selective Site Demolition.
B. Section 31 0000 - Earthwork.
C. Section 31 1000 - Site Clearing.
D. Section 31 2333 - Trenching and Backfilling.
E. Section 33 4000 - Storm Drainage Utilities.

1.03 REFERENCES

A. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012.
F. Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction". Only applicable portions of construction methods and materials apply. References to methods of measurement or payment are not applicable.
   1. MN/DOT 3733 - Geotextiles
   2. MN/DOT 3876 - Seed
   3. MN/DOT 3885 - Rolled Erosion Control Products

1.04 PERFORMANCE REQUIREMENTS
A. Comply with all requirements of the City of Minneapolis for erosion and sedimentation control.
B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
C. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
D. Erosion On-site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
E. Erosion Off-site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud onto public roads outside site.
   3. Prevent mud and sediment from flowing onto sidewalks and pavements.
   4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
F. Sedimentation of Waterways On-site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways and sewers.
1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

G. Sedimentation of Waterways Off-site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways and storm sewers.

1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

H. Open Water: Prevent standing water that could become stagnant.

I. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.05 GENERAL
A. Exercise every precaution, throughout the life of the project, to prevent the eroding of soil and the silting of rivers, streams, lakes, reservoirs, other water impoundments, ground or roadway surfaces, or other property. Erosion control practices to be used for this project are as indicated on the Drawings and directed by the local governing agency.

B. The Contractor is solely responsible for the cleanup of any rivers, streams, lakes, reservoirs, other water impoundments, ground or roadway surfaces or other property damaged by construction activity related to this project.

C. Coordinate the placement of temporary turf establishment provisions with the placement of permanent turf establishment.

1.06 QUALITY CONTROL
A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

B. Conform to all applicable code for materials and installation of the Work of this Section.

C. Verify that survey bench mark and intended elevations for the Work are as indicated.

1.07 REGULATORY AGENCIES
A. Comply with requirements of state, regional, and local erosion and sediment control regulatory authorities.

1.08 SUBMITTALS
A. Submit under provisions of Division One Specifications.

B. Product Data: Submit manufacturer’s product data for silt fence materials; including fabrics and posts.
PART 2 PRODUCTS

2.01 EROSION CONTROL BLANKETS
A. Blankets are machine produced mats consisting of a uniform web of interlocking straw fibers with net backing. The blankets shall be a consistent thickness with the fiber evenly distributed over the entire area of the blanket. The top and bottom sides of each blanket are covered with a polypropylene plastic mesh. The blanket is smolder-resistant without the use of chemical additives. The Blanket shall meet the requirements of MN/DOT 3885 Category 3, Straw 2S. Provide erosion control blankets such as “American Excelsior Company Curlex I” “Contech Standard Excelsior”, “North American Green S-75” or approved equivalent by the Architect/Engineer.

1. Erosion blankets shall be used at slopes and berms, ditches, and other “hard to hold” problem areas.

2.02 INFRASAFE SEDIMENT CONTROL BARRIER
A. Infrasafe sediment barrier is manufactured by Royal Environmental Systems Inc. Stacy, MN.
B. The Infrasafe sediment control barrier device consists of a reusable polyethylene product. The barrier and frame set inside of the access opening or hole of the top slab or cone section of the catch basin structure. The polyethylene barrier is manufactured with perforations in its sidewalls and is wrapped in a geotextile fabric to allow storm water runoff to drain into the structure. A larger opening near the top of the barrier allows greater amounts of water into the system during large rainfall events.

2.03 WIMCO ROAD DRAIN PROTECTION DEVICES
A. WIMCO Road Drain protection devices are manufactured by WIMCO Inc. Shakopee, MN.
B. Material:
   1. Model # RD23, Road Drain.
   2. Model # CG23, Curb and Gutter Drain.
   3. The WIMCO road drain protection device consists of a reusable, open topped receptacle that sets inside the storm sewer grate. An incorporated rear deflector plate is connected to the receptacle directing the water into the basin for filtration.
   4. The filter media shall meet all local specifications for inlet protection.

2.04 SILTSACK
A. Material:
   1. The SILTSACK or approved equal shall be manufactured from woven polypropylene fabric with all seams double stitched using nylon thread.
   2. The seams shall have certified average wide width strength per ASTM D4884/D4884M as follows:
      a. Style Test Method Test Result
      b. Regular Flow ASTM D4884/D4884M 165.0 lbs./in.
      c. Hi Flow ASTM D4884/D4884M 114.60 lbs./in.
B. Procurement of the devices shall be obtained from ACF Environmental, Inc., 1801-A Willis Road, Richmond, Virginia, 23237, phone number 1-800-644-9223.

C. Substitutions: Under the provisions of Division One Specifications.

2.05 TEMPORARY SEED

A. For temporary spring/summer cover, a MN/DOT 21-111 (oats) seed mix shall be applied. For a fall cover, a MN/DOT 21-112 (winter wheat) seed mix applied. Apply seed mix at a rate of 100 pounds per acre.

2.06 ROCK FOR TEMPORARY CONSTRUCTION ENTRANCE

A. One and one-half (1.5") inch to three (3") inch crushed rock meeting ASTM D448, Gradation Number two (2).

2.07 GEOTEXTILE FABRIC UNDER ROCK CONSTRUCTION ENTRANCE

A. MN/DOT Spec 3733, Type III shall be used under rock construction entrance.
B. Minimum grab tensile strength, ASTM D4632/D4632M, 100 pounds Class III.
C. Minimum elongation, ASTM D4632/D4632M 50%.
D. Minimum seam breaking strength, ASTM D4632/D4632M, 90 pounds Class III.
E. Apparent opening size ASTM D4751, 50 US Std. Sieve size.
F. Minimum permittivity falling head ASTM D4491, 0.5.

2.08 STRAW MULCH

A. Straw: Dry, rot free small grain cuttings free of seed bearing stalks of noxious grasses and weeds. The mulch shall be in an air-dried condition.

2.09 STRAW LOGS (BIOLOGS)

A. Straw logs consist of 100-percent straw fibers, free of noxious weeds, and are sewn to a light weight degradable net and densely rolled and bound with an outer high strength polyethylene netting with UV inhabitation. The logs shall be staked into the ground using one (1") inch by one (1") inch by two (2') foot wood stakes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 GENERAL

A. Construct and maintain all erosion control measures until the Substantial Completion of the project, or as directed by the Architect/Engineer.
B. Install temporary erosion and sediment control items prior to site preparation.
C. Install erosion control items as detailed and in locations shown on the Drawings and as required by permit.

D. The Contractor shall schedule and conduct their operations to minimize the erosion of soils, to prevent siltation, and to minimize the turbidity of storm sewer runoff entering storm sewers, streams, ditches and lakes.

E. No work shall be started in the affected area until the applicable erosion control schedules and methods have been accepted by the designated erosion control inspector.

F. The Contractor shall install adequate safeguards to minimize water pollution from haul roads, work platforms, temporary earthen fills and any other temporary construction that he uses to facilitate construction. The Contractor shall obtain all necessary permits from the regulatory agencies for temporary work not shown on the Drawings.

3.04 EROSION CONTROL

A. The Contractor shall install sediment traps at existing and proposed catch basins within the construction zone. Sediment traps shall remain in place until turf and pavement surfaces are established. Filter fabric between casting and frame will not be allowed. Contact Architect/Engineer prior to removal.

B. Repair or replace any erosion control devices that have been disrupted during operations as required by local regulation. This work and material shall be considered part of the Base Bid Contract and no additional compensation shall be made therefore.

C. Silt fence and sediment control devices are to be installed and shall to remain in place until turf has been established. Contact the Architect/Engineer prior to removal.

D. The Contractor shall schedule and conduct their operations so as to minimize erosion of soils and to prevent silting and muddying of streams, irrigation systems, and impoundments (lakes, reservoirs, etc.). Construction of drainage facilities, turf establishment items, and other Contract Work that will contribute to the control of erosion and sedimentation shall be carried out concurrently with earthwork operations or as soon thereafter as practicable.

E. Where erosion is likely to be a problem and where potentials for water pollution exist, the Contractor shall prepare and submit to the Architect/Engineer for acceptance, their proposed schedules for accomplishment of the effected Work, including any temporary measures proposed. No work shall be started in the affected areas until the applicable erosion control schedules and the Architect/Engineer has accepted the proposed methods of operation.

F. The Architect/Engineer shall have authority to limit the surface area of erodible soil that can be exposed to possible erosion at any time, without having the permanent erosion control features completed and operative.

G. While operations are in progress and prior to suspension of grading operations for longer than fourteen (14) days, areas of bare soil exposed to erosion possibility shall be shaped to permit storm runoff with minimum erosion. Temporary berms, dikes, slope drains or sedimentation basins will be required where possibilities for water pollution exist and the permanent erosion controls are not completely operative.

H. Erosion control devices shall remain in place until other means of permanent control such as turf establishment and paving has taken place.
I. Application of erosion control blanket: Where slopes are greater than three (3') feet horizontal to one (1') foot vertical and in areas as indicated on the Drawings, straw fiber blanket (regular type) per MN/DOT Specification Section 3885.2 shall be applied.

J. Restoration:

1. Control of drainage and erosion shall include restoration work as the Architect/Engineer considers necessary in preventing siltation of public waters. Restoration shall include cleanup, shaping, and replacement of topsoil and establishment of vegetative cover on all disturbed areas where water pollution potentials have been increased due to the Contractor's operations.

K. Compensation:

1. All expenses incurred in complying with the provisions hereof and effectively preventing pollution of public waters or public infrastructure shall be borne by the Contractor with no direct compensation being made therefore.

3.05 Installation of Straw Logs:

A. The straw logs shall be placed on slopes along the contour, perpendicular to the flow of water to help capture sediment. They may be placed within a channel or ditch along the contour to create mini dams within the ditch of trench. The hay bales should be installed on the contour with the ends flared upslope.

B. The spacing should be approximately ten (10') to twenty-five (25') feet apart depending on the site conditions. A closer spacing shall be used in areas with sandy soils and high storm water runoff areas of with heavy sediment loads. A wider spacing may be used in areas with dense soil, low storm water runoff or areas with light sediment load.

C. Maintenance:

1. When straw logs have sedimentation built-up to one-third height, the Contractor is to remove the build-up. The soils are either to be taken off the site or to a location on the site where it can be used (contact the Soils Engineer prior to placement). The relocation and cleanup of sediments is part of the Base Bid Contract.

2. The cost of installation, maintenance and removal shall be considered part of the Base Bid Contract with no additional compensation granted.

3.06 WIMCO ROAD DRAIN PROTECTION DEVICES - INSTALLATION

A. Remove the grate from the storm sewer casting.

B. Clean all edges of the casting frame.

C. Place filter media over the filter cartridge and install to unit.

D. Insert the receptacle into the casting frame.

E. Install casting grate on top of the model making sure the grate is secure for traffic.

F. The maximum height change should be 1/8” of the casting cover to frame

G. Installation, Maintenance and Removal:

1. The devices shall be sized to fit the catch basin opening and shall be fastened according to the manufacturer's instructions.
2. The sediment control device shall be removed, emptied and replaced when the level of silt rises above the midpoint.

3. The sediment control device shall be permanently removed only after permanent surfaces are established and all loose silt on the surface adjacent to the device has been removed. Removal shall be coordinated with the City Erosion Control Officer.

H. The cost of installation, maintenance and removal shall be considered part of the Base Bid Contract with no additional compensation granted.

3.07 EROSION CONTROL BLANKET - INSTALLATION

A. Properly prepare, fertilize and seed areas to be covered before blanket is applied. When the blanket is unrolled, netting should be on top and fibers in contact with the soil over the entire area.

B. In ditches, apply blankets in the direction the water flows, butting them at the ends and sides and then stapling.

C. On slopes, apply blankets vertically to the slope, parallel to the direction of flow, butting ends and sides and then staple.

D. Use wire staples, ninety-one one-thousandths (0.091") inch in diameter or greater, “U” shaped with legs six (6") inches in length and a one (1") inch crown. Size and gauge of staples used will vary with soil conditions. Drive staples vertically into the ground. Use four (4) staples across at the start of each roll. For slope installation, continue to staple along the length of the roll at six (6') foot intervals. For ditch liner, staple along the length of the roll at four (4') foot intervals. Another row of staples in the center of each blanket should be alternately spaced between each side of either the slope or the ditch. Use a common row of staples on adjoining blankets.

3.08 CONSTRUCTION ENTRANCE

A. Construct a gravel area or pad at points where vehicles enter and leave the construction site. The rock entrance shall be a minimum of 50 feet long.

B. Clear the entrance and exit area of all vegetation, roots and other objectionable material and properly grade and place gravel to the grade and dimensions shown on the Plans.

C. Construct drainage channels to carry water to a sediment trap or other suitable outlet.

D. Install geotextile fabric under rock to improve the stability of the foundation.

E. Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site by periodic top dressing with two (2") inch stone.

F. After each rainfall, inspect any structure used to trap sediment and clean it out as necessary.

G. Immediately remove sediment spilled, washed or tracked onto public roadways.

3.09 TEMPORARY SEEDING

A. Seeding:

1. Apply seed per the rate indicated under Products - Temporary Seed of this Section.

2. The seedbed should be prepared to a depth of approximately 3 inches. In compacted or hard soils, use a disc or ripper to prepare the seedbed by loosening a minimum of the top three inches of soil. The seedbed preparation should not be prepared under excessively wet conditions.
3. Seed should be evenly applied with a cyclone seeder, drill or cultipacker seeder at a seeding depth of ½ inch, ensuring good seed to soil contract.

4. The grass area shall be mulched with a MN/DOT 3882 Type 1 mulch at the rate of 2 tons per acre. Once the area is mulched, the mulch shall be disc-anchored into the soil.

5. Erosion control blankets shall be installed as specified for the following areas:
   a. Slopes that are 3:1 or steeper.
   b. Hard to hold problem areas.

B. Provide a temporary cover for erosion control on disturbed areas that will remain unstabilized for a period of more than thirty (30) days. This practice applies to cleared areas, diversions, dams, temporary sediment basins, temporary road banks and topsoil stockpiles where vegetation is needed for less than one (1) year.

C. Provide grass on slopes 5 percent or greater within fourteen (14) days of disturbance.

D. Provide water if necessary to aid the establishment of the turf.

3.10 INLET PROTECTION
A. Install WIMCO, Infrasafe or other approved sediment barrier devices around the storm drain inlets per manufacturer's specification and as detailed within the Drawings.

B. Infrasafe sediment barriers shall be surrounded with 3/4-inch minus washed rock to filter the storm water runoff prior to it draining through the weep holes in the barrier device.

C. Construct temporary sediment barriers around the storm drain curb inlets using block and gravel silt fence or interior sacks per City and State standards and specifications. Installation shall be as detailed on drawings.

D. Inspect the structure after each rainfall and repair, clean or replace as required.

E. Remove sediment when trap reaches one-third (1/3) capacity.

F. Remove structure when protected areas have been stabilized.

3.11 TEMPORARY SEDIMENT TRAPS
A. Utilize temporary sediment traps at the bottom of all disturbed slopes where run-off is parallel to the utility trench and draining into an existing ditch or stream, and where slopes are 5 percent or greater along the trench.

B. Provide at intervals of seventy-five (75') feet.

3.12 REMOVAL AND CLEAN UP
A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect/Engineer.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION
SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers’ standard warranties on products; special warranties; and comparable products.

B. Related Requirements:
1. Section 01 23 00 "Alternates" for products selected under an alternate.
2. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
3. Section 01 42 00 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS
A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.

2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

3. Comparable Product: Product that is demonstrated and approved by Architect through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named
product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.

1.4 ACTION SUBMITTALS

A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Form of Architect's Approval of Submittal: As specified in Section 01 33 00 "Submittal Procedures."
b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

a. Name of product and manufacturer.
b. Model and serial number.
c. Capacity.
3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:
   1. Store products to allow for inspection and measurement of quantity or counting of units.
   2. Store materials in a manner that will not endanger Project structure.
   3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
   4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
   5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
   6. Protect stored products from damage and liquids from freezing.
   7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

   1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer’s Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor’s convenience will not be considered.
   a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: …"

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor’s convenience will not be considered.
   a. Sole manufacturer/source may be indicated by the phrase: “Subject to compliance with requirements, provide products by the following: …”

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements.
   a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: …"
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
   a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: …"

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
   a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: …"

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
   a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: …"

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
   a. For approval of products by unnamed manufacturers, comply with requirements in Section 01 25 00 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
   1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Comparable products to be considered during bidding period only.
2. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

B. Submittal Requirements: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION
1.01 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Select any product meeting those standards.

B. Products Specified by Naming Several Manufacturers: Select any one (1) of the products or manufacturers named, which comply with the Specifications. No options means no substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a Request for Substitution for any manufacturer not specifically named.

1.02 PRODUCTS LIST

A. Within ten (10) calendar days after date of written Contract Notice to Proceed, submit to the Architect for approval, a complete list of major products proposed for use. See Specifications Section 01 33 00-1.04 for details of required information.

1.03 SUBSTITUTIONS BEFORE BID OPENING

A. Submit to the Architect a separate Request for Substitution on a copy of the sample “Request for Substitution” Form as included at the end of this Section for each product proposed for substitution, supported with complete data, drawings and samples as appropriate, including:
   a. Comparison of the qualities of the proposed substitution with that specified.
   b. Changes required in other elements of the Work because of the substitution.
   c. Availability of maintenance service and source of replacement materials.

B. The Architect will be the judge of all Requests for Substitutions received not less than five (5) working days before the Bid Opening.

C. A Request for Substitution constitutes a representation that the person submitting the request:
   a. Has investigated the proposed product and determined that it is equal to or superior in all respects to that specified,
   b. Will provide the same warranties or guarantees for the substitution as for the product specified,
   c. Will coordinate the installation of an accepted substitution into the Work, and make such other changes as may be required to make the Work complete in all respects at no additional cost to the Owner.
   d. Waives all claims for additional costs, under their responsibility that may subsequently become apparent.

D. Architect will review Requests for Substitution with reasonable promptness, and notify all Bidders by Addendum of the decision to accept the requested substitution.

E. Requests for Substitution not submitted in accordance with the procedures described in this Paragraph will not be reviewed or considered by the Architect.

1.04 SUBSTITUTIONS AFTER BID OPENING
A. Requests for Substitutions received after Bid Opening will not be considered except in such cases where it is necessary to make a substitution due to strikes, lockouts, bankruptcy, discontinuance of a product, and similar circumstances. Such Requests for Substitution of materials after Contract Award shall be made in writing to the Architect and shall be made within ten (10) days of the date that the Contractor ascertains they cannot obtain the material or equipment specified.

B. Requests for Substitution will not be considered when they are indicated or implied on Shop Drawings or Product Data submittals without a separate previously submitted Request for Substitution Form, or when acceptance will require substantial revision of the Contract Documents.

C. The Architect with approval by the Owner will be the judge of the acceptability of all Requests for Substitution received after Bid Opening.
REQUEST FOR SUBSTITUTION FORM

NORTH REGIONAL LIBRARY REFURBISHMENT
MINNEAPOLIS, MINNESOTA

DATE:

TO: Attn: Jessica Kraft
   Bentz/Thompson/Rietow, Inc.
   900 Second Ave. So., Suite 400
   Minneapolis, MN 55402
   Telephone: 612-332-1234

SPECIFICATION NO._________________________ PARAGRAPH NO._____________________

SPECIFIED PRODUCT:______________________________________________________________

PROPOSED SUBSTITUTION:_________________________________________________________

REASON FOR SUBSTITUTION:_______________________________________________________

ATTACH COMPLETE TECHNICAL DATA, LITERATURE AND SAMPLE IF APPLICABLE

A. Does proposed substitution fail to satisfy, in any respect Characteristics specified for original product(s)? ___Y ___N

B. Does substitution affect dimensions shown on Drawings? ___Y ___N

C. Does substitution affect other trades? ___Y ___N

D. Does warranty differ from that specified? ___Y ___N

E. Does substitution affect cost to Owner? ___Y ___N

   If so, how much? Add $_____________ Deduct $_____________

F. If you indicated “Yes” to any of the items above, attach thorough explanation on your Company letterhead as follows:

   a. Explain any differences between proposed substitution and specified product.

   b. Summarize experience with product and manufacturer in Project area.
The undersigned states that the function, appearance and quality of the proposed substitution is equivalent or superior to the specified item, unless noted otherwise, and that all information above and attached is true and correct.

Submitted by:________________________________________________________

Position:___________________________________________________________

Company:___________________________________________________________

Address:___________________________________________________________

City, State, Zip:_____________________________________________________

Telephone:________________________________________________________

Date:______________________________________________________________

Signature:__________________________________________________________

For use by Architect:

Accepted:__________________________________________________________

Accepted as Noted:__________________________________________________

Not Accepted:_______________________________________________________

Received Too Late:__________________________________________________

By:_______________________________________________________________

Date:______________________________________________________________

Remarks:___________________________________________________________

Included in Addendum: Yes_____ No_____

Addendum No.:________________

END OF SECTION
PART 1 – GENERAL

1.01 SURVEYS AND RECORDS

A. Site Control: Working from lines and levels established by the Drawings and/or existing conditions, the Prime Contractor shall establish and maintain benchmarks and other dependable markers for site control. Establish benchmarks and markers to set lines and levels for Work, key elevations and elsewhere as needed to properly locate each element of the Project. Calculate and measure required dimensions within recognized tolerances. Drawings shall not be scaled to determine dimensions. Advise all Subcontractors performing Work, of marked lines and levels provided for their use.

B. Survey Procedures: Before proceeding with the layout of actual Work, verify the layout information shown on the Drawings with the Architect/Engineer. As Work proceeds, check every major element for line, level and plumb. Advise the Architect/Engineer promptly upon detection of deviations. Record all deviations from locations, lines and levels shown on the Drawings on Record Drawings.

C. All as-built locations of existing and new utility lines below grade shall be marked on the Record Set drawings for specific grid location and depth.

1.02 SUBCONTRACTOR LAYOUT AND MEASUREMENTS

A. The responsibility for accurate layout and measurement of the Work of each Subcontractor is their own. In addition, each Subcontractor shall verify the dimensional accuracy of the preceding Work upon which their Work relies before they begin their own Work. Each Subcontractor shall report all inaccuracies to the Prime Contractor and shall not proceed until corrections or clarifications are made. If a Contractor or Subcontractor proceeds with their Work on dimensionally inaccurate Work of another Subcontractor, they shall be liable for the cost of corrections to their own Work when the error is corrected, and shall cooperate in the corrective Work at no additional cost to the Owner.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Cutting, demolition, removal, patching and restoration of Work to accomplish and complete Work under this Contract.
   2. Relocation or reuse of existing materials, equipment, systems, or other work, as well as disposition of salvaged materials or debris.
   3. This Section applies to each subcontractor under this Contract.
B. Related Sections:
   1. Section 024119 – Selective Demolition.

1.2 DESCRIPTION
A. Drawings show design intent for scope of demolition, removals, relocations and cutting. Drawings may not show or indicate each Work item needed and may not indicate each condition or detail encountered to accomplish Work of this Contract.
   1. Examine spaces to determine actual conditions and requirements. Perform removal, demolition, cutting, restoration, new installations and other Work to accomplish new conditions required under Contract including connection of new to existing.
B. Each trade is to perform demolition, cutting, removals, relocations, patching and restoration required to accomplish Work under each Subcontract.
   1. Mechanical Subcontractor removes or relocates piping, ductwork and other items typical to its trade.
   2. Electrical Subcontractor removes or relocates panelboards, conduit, lighting and other items typical to its trade.
   3. General Construction demolishes and removes abandoned or unwanted electrical or mechanical materials and other general construction items in space.

1.3 SUBMITTALS
A. Schedule: Submit schedule indicating proposed sequence of operations for demolition work to Owner and Architect for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.
   1. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
   2. Coordinate with Owner's continuing occupation of portions of existing building and with Owner's partial occupancy of completed new addition.

1.4 QUALITY ASSURANCE
A. Skilled Mechanics: Accomplish all work of cutting, removal, demolition, relocation, patching and other restoration by using only mechanics skilled in the trade. If necessary, sublet the work to skilled contractors or subcontractors.
B. Hazardous Substances: If removals, demolition, cutting and similar work results in discovery or impact to possible hazardous substances and/or harmful physical agents, such as asbestos fibers, or polychlorinated biphenyl (PCB), avoid damage to hazardous substance and protect safety of persons. Immediately notify Owner and Architect in accordance with provisions of AIA General Conditions.

1.5 COORDINATION

A. Coordination: Coordinate Work of this Section with each subcontractors so Work will progress without interruption and minimum delays. Contractor must also coordinate and schedule Work with Owner where possible disturbance may occur and where relocations or other potential disruptions of Owner's functions and services may occur. Work affecting Owner's functions and services shall be performed at times acceptable to Owner.

PART 2 DISPOSITION OF MATERIALS

2.1 UNSALVABLE MATERIALS

A. Remove unsalvable materials in a manner that will avoid damage to materials or equipment which will remain. Completely remove and legally dispose away from the site.

2.2 SALVABLE MATERIALS TO BE RE-USED IN THE WORK

A. Salvable materials and items designated for reuse or relocation shall be removed by the applicable trades and relocated to the new location. If the new location is not ready to receive the relocated item, it shall be stored and protected from damage until incorporated into the new work or remodeled area. If the Owner is unable to forego the use of any existing items at the normal time for relocation until other facilities are available to the Owner, make all preparations for the item and delay relocation until a time approved by the Owner.

B. Carefully remove, salvage, clean and preserve materials, equipment and other items indicated to be reused, or which will be needed for reuse to match existing work. Exercise extreme care in removals to prevent damage or to make materials unsuitable to reuse. For materials shown or called for to be reused and which are damaged, replace with equivalent and matching work.

2.3 SALVABLE MATERIALS TO BE STORED BY THE OWNER

A. The Owner will mark or tag existing materials, equipment or other items Owner wishes to retain. Salvable materials and items designated or marked to remain the property of the Owner shall be carefully removed by the applicable trades, protected from damage and stored adjacent to the removal area as directed.

B. Consult the Owner for any salvage the Owner may wish to retain and the salvageability of all items. Carefully remove and salvage any materials the Owner wishes to retain. Remove finish hardware from the item or material taken out of the building and turn over to Owner. Cleaning or restoration of the Owner's salvage materials is not required.

C. If off-site storage is required by the Owner, removal from the area and the site to the Owner's storage will be by the Owner.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

B. After uncovering, inspect conditions affecting performance of work.

C. Beginning of cutting or patching means acceptance of existing conditions.

3.2 TEMPORARY PROTECTION
A. Provide temporary bracing, shoring, needling and support during demolition, cutting, remodeling and related new construction as necessary for the execution of the Work and the protection of persons and property. Perform all work with appropriate supports, protection and methods to prevent collapse, settling or damage to property or persons. Provide adequate supports for the loads to be carried, with loads properly distributed, including to lower levels and sound bearing, if necessary.

B. Provide protective coverings and enclosures necessary to prevent damage to existing spaces and materials to remain. Protect openings in exterior walls and roofs so as to prevent damage from water and the elements and prevent excessive heat loss from the existing buildings. Coordinate work and removals at exterior, including roof, by scheduling and performing to maintain watertight installation. Seal areas left temporarily unfinished to prevent damage to existing roof or other materials and furnishings of existing building.

C. Provide dustproof temporary enclosures (including above ceilings) separating areas under demolition and remodeling from the remainder of the building as well as temporary filters at duct work. Provide temporary hinged doors in temporary enclosures where necessary. Temporary and permanent doors shall be completely sealed with tape or other suitable material during demolition work and shall remain sealed until dust has settled.

D. Provide protection from elements for that portion of the Project which may be exposed by cutting and patching work, and maintain excavations free from water.

3.3 DEMOLITION AND CUTTING

A. Demolish and remove existing construction as shown, indicated or required to be removed to accomplish the Work. Where new Work is to be installed in or adjacent to existing construction or existing work is to be replaced, remove or cut the existing construction as necessary to complete the Work of the Project.

B. Execute work with care. Existing construction that is to remain which is loosened, cracked, or otherwise damaged or defaced as a result of the Work and is unsuitable for use intended shall be removed and replaced at no additional cost to the Owner.

C. Debris from upper levels shall be transported to ground in covered chute or other approved means. No free-fall debris removal is permitted. Take all precautions to minimize dust.

D. Clean demolition areas and remove debris, waste and rubbish from the building at the conclusion of each day's work. Transport debris and rubbish in such a manner so as to prevent spread of dust. Do not store or permit debris storage at site. Do not burn debris, rubbish or waste at the site. Keep adjacent areas unencumbered and clean. Keep walks and similar areas broom clean.

3.4 PATCHING, REMODELING, REPLACEMENTS AND RESTORATION

A. Patch or otherwise restore disturbed existing construction as indicated on Drawings and schedules, or as otherwise required to restore the work and surfaces. Patching or restoration shall be carried to natural breaks (i.e., corners) wherever possible. Where existing construction is removed, cut or otherwise disturbed by Work of the Project, patch defective and incomplete surfaces. Repair damage to existing construction which is to remain.

B. Patching work shall be done by skilled mechanics experienced in the particular type of work involved. Patching work shall conform to the standards of the Specifications where applicable and where not specified, work shall conform to the highest standards of the trade.

C. Patch existing construction to match existing work (unless otherwise called for) except provide new materials and accomplish as for new work. Examine existing surfaces to be patched before proceeding with the work. Report all conditions where existing materials, colors and finishes cannot be matched to the Architect and Owner, and do not proceed until instructions have been given.

D. Existing construction that has been damaged as a result of the Work shall be repaired to an extent and as required to match adjacent existing undamaged construction.
E. Thoroughly clean and prepare all surfaces to receive new finish or covering. Completely remove dirt, dust, grease, oil, paint, loose materials and soil. Clean, etc where necessary, and place surfaces in most suitable condition for the finish.

3.5 ADJUSTMENTS
A. Where partitions are removed, patch floors, walls, and ceilings, with finish materials to match existing.
   1. Where removal of partitions results in adjacent spaces becoming one, rework floors and ceilings to provide smooth planes without breaks, steps, or bulkheads.  
   2. Where extreme change of plane of two inches or more occurs, request instructions from Architect as to method of making transition.
B. Trim and refinish existing doors as necessary to clear new floors.

3.6 MECHANICAL AND ELECTRICAL WORK EXPOSED
A. Where unknown mechanical piping, ductwork or electrical conduit is exposed during removal of partitions, walls or floors and ceilings, the removal or rerouting shall be accomplished by the Mechanical or Electrical Subcontractor as applicable. Locate mechanical and electrical work where directed and connect to maintain all functions in proper operation. Abandoned piping may be left in place where it is concealed in floors or walls, providing that it is disconnected from its source and capped. There shall be no "dead end" water, sewer, gas, or vent piping existing in the completed work.
B. Accomplish removals, capping or otherwise terminating services which are abandoned or need to be abandoned, and rerouting of mechanical and electrical work without additional cost to the Owner, whether shown or noted on drawings or otherwise encountered.

3.7 WORK AT EXISTING ROOF
A. Verify with the Owner to ascertain the existence of an existing roof bond or guarantee. Cutting and patching of existing building roof shall be performed with compatible materials using methods so as not to invalidate any current bond or guarantee. Cutting of all openings through roof shall be done by manufacturer’s licensed or approved roofing contractor. Arrange with the manufacturer who furnished the roof bond or with the roofer who provided the roof guarantee for an examination of the complete work and provide two copies of an acknowledgement and/or approval to the Owner indicating that such bond or guarantee (if any) will remain in effect.
B. Spud off gravel about 4 feet back from roof penetration at areas indicated on roof plan and/or details at existing roof construction. Remove and patch materials to extent indicated. Feather roofing plies back, down to existing insulation; remove cut or damaged insulation and provide new insulation where required. New felts shall overlap each other and stagger back onto existing roof at successive plies. Provide at least four (4) plies. Flood coat new roof membranes and re-gravel where required.
C. At existing membrane roof system, cut and patch membrane and insulation as required at penetrations. Remove and patch materials to extent indicated. Remove cut or damaged insulation and provide new insulation where required. Re-gravel where required.

3.8 WORK OF EACH CONTRACT
A. The Contractor and each subcontractor must carefully review the Contract Documents including those primarily for other trades with respect to the coordination of the demolition, removal and remodeling work and perform such removals normal to their trades as may be shown, noted or otherwise required. Cutting and patching incidental to demolition, removal and/or remodeling of general construction work shall be construed as the work of the General Contractor when shown or indicated on the general construction drawings or schedules or specifically noted or called for on documents primarily for other trades as being accomplished by the General Contractor. Other subcontractors (mechanical or electrical) are responsible for such other cutting, demolition, patching, replacement and restoration as may be required to accomplish their part of the Work.

Hennepin County Cutting and Patching
North Regional Library Refurbishment
3.9 PAINTING
A. Each major subcontractor (mechanical, electrical) shall be responsible for painting or repainting of patched or remodeled areas where they have performed work, except for those areas shown or required to be remodeled under the general construction drawings, specifications or schedules, in which case, the new, patched and remodeled paintable surfaces shall be repainted by the General Contractor. It is the intent that the mechanical and electrical subcontractors are responsible to paint or repaint surfaces at locations where demolition, cutting and patching has been accomplished only for their work.
B. Painting, including preparation, materials, workmanship and number of coats shall comply with Section 099000 - Painting. Painting of surfaces patched shall extend to natural breaks, such as corners, as approved by the Architect and Owner.

3.10 FLOOR PREPARATION (EXISTING SLABS)
A. Prepare existing concrete slabs for the installation of various floor finish materials, i.e., VCT, ceramic and quarry tile, carpet (glue-down), concrete topping.
B. Roughen surfaces which are glossy or which have loose surface material or curing sealers by sanding, scarifying or acid etching as required. Remove surface material that is not compatible with adhesive. Clean thoroughly to remove all oil, dirt, sealer materials and dust.

3.11 CLEANING
A. Perform periodic and final cleaning as specified in Section 017700 - Closeout Procedures.
   1. Clean Owner-occupied areas daily.
   2. Clean spillage, overspray, and heavy collection of dust in Owner-occupied areas immediately.
B. At completion of work of each trade, clean area and make surfaces ready for work of successive trades.
C. At completion of alterations work in each area, provide final cleaning and return space to a condition suitable for use by Owner.

END OF SECTION
PART 1 – GENERAL

1.01 REQUIREMENTS INCLUDED

A. Cleaning of Project

1.02 RELATED REQUIREMENTS

A. Document 00 72 00 – General Conditions: Clean-up.
B. Section 01 50 00 – Temporary Facilities and Controls: Cleaning during construction.
C. Section 01 74 19 – Construction Waste Disposal and Recycling
D. Individual Specifications Sections: Specific cleaning for product or Work.

1.03 DESCRIPTION

A. The Contractor and Subcontractors shall execute cleaning regularly during the progress of the Work, and at completion of the Work, as required by the General Conditions and the Specifications.
B. Maintain premises and public properties free from accumulations of waste, debris, and rubbish caused by operations. Maintain public use areas clear of debris at all times.
C. Conform to the requirements of authorities having jurisdiction.
D. At completion of Work, remove waste materials, rubbish, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces; leave Project clean and ready for occupancy.

1.04 SAFETY REQUIREMENTS

A. Standards: Maintain Project in accord with requirements of all authorities having jurisdiction.
B. Hazards Control:
   1. Store volatile wastes in covered metal containers and remove from premises weekly.
   2. Prevent accumulation of wastes, which create hazardous conditions.
   3. Provide adequate ventilation during use of volatile or noxious substances.
C. Conducting cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
   1. Do not burn or bury rubbish and waste materials on Project site.
   2. Do not dispose of volatile wastes, such as mineral spirits, oils, or paint thinner, in storm or sanitary drains.
   3. Do not dispose of wastes into streams or waterways.
1.05 SOLID WASTE DISPOSAL SERVICE

A. The Contractor shall provide containers on the site for the disposal of all types and quantities of construction debris and include the cost of these services in their bid.

B. The Contractor shall determine and comply with all applicable special requirements and regulations affecting solid waste disposal of materials from the Project site to a legal, off-site disposal location.

C. Each Subcontractor shall cooperate with the Prime Contractor regarding the disposal service. Any anticipated disposal requirement that is beyond normal workscope operations shall be approved in advance by the Prime Contractor.

D. Disposal of excess or removed materials for some portions of the Work will not be allowed through the disposal service. Subcontractors involved in handling the following materials shall make their own separate arrangements for disposal off-site:
   
   3. PCB-Containing Electrical Equipment and Components.

E. The Contractor shall locate containers only at those locations as approved in advance by the Architect and Owner.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials that will not create hazards to health or property, and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by the manufacturer or the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by the cleaning material manufacturer.

D. The Contractor shall provide or arrange for cleaning materials and equipment.

PART 3 – EXECUTION

3.01 REGULAR HOUSE KEEPING AND CLEAN-UP

A. The Contractor shall execute regular daily housekeeping to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction demolition and operations.

B. The Contractor is financially responsible for its own clean-up operations. Clean-up shall be timely as well as thorough in order to meet safety regulations and permit other Subcontractors to perform without hindrance from dirt and debris. The Prime Contractor shall coordinate Project housekeeping, and take appropriate steps to maintain clean, safe working conditions. Subcontractors failing to meet housekeeping requirements will be charged for services arranged by the Prime Contractor.
C. If Contractor cleaning is not maintained and regularly executed in accordance with the requirements of these Specifications as determined by the Architect or the Owner, and the Contractor is so notified in writing by the Architect or the Owner, the Owner may complete the necessary cleaning using others and backcharge the costs of all such work to the Contractor.

3.02 CLEANING DURING CONSTRUCTION

A. The Contractor and each Subcontractor shall:

1. Conform to environmental protection requirements of authorities having jurisdiction.

2. Handle materials in a controlled manner with as few handlings as possible: do not drop or throw materials from heights. Where possible, all materials to be disposed of shall be loaded directly into trucks by means of approved chutes or other methods that will prevent damage to existing, or new, surfaces, adjacent public areas and to control pollution.

3. Remove debris produced by the Work as it occurs, **daily**, to solid waste disposal containers.

4. Maintain electrical closets, pipe and duct shafts, chases, furred spaces, and similar spaces, which are generally unfinished, free from rubbish, extraneous construction materials, dirt and dust.

5. **Execute cleaning at the end of each day’s operations** to ensure that building, grounds, and public properties are maintained free from accumulations of waste materials, debris and rubbish.

6. Provide on-site containers for collection of waste materials, debris and rubbish.

7. Remove waste materials, debris and rubbish from site and legally dispose of off Owner’s property.

8. Necessary controls shall be provided to prevent pollution of the air by odors or particulate matter. The location and operation of existing and temporary ventilation and heating equipment shall be coordinated in advance such that no hazard is created and objectionable odors do not enter the building.

3.03 DUST CONTROL

A. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly coated surfaces.

C. Seal all doors, windows and cracks of temporary enclosures with tape and similar means to minimize dust infiltration into occupied spaces.

3.04 PREFINISHED METAL AND GLASS REPLACEMENT

A. The responsible Subcontractor shall assume all costs of replacement of prefinished metal and glass, broken, cracked or damaged prior to Final Completion of the Project. Glass scratched through improper cleaning shall be considered damaged and shall be replaced by the party that caused the damage.
3.05 FINAL CLEANING

A. The Contractor shall employ experienced workers, or professional cleaners, for final cleaning caused by Contractor operations.

B. In preparation for and prior to Substantial Completion or Owner Occupancy, the Prime Contractor shall remove protective coatings, barriers and other protective devices and all temporary Work. The Prime Contractor shall conduct an inspection of exposed interior and exterior surfaces and all Work areas, to verify the entire Project is clean.

C. In preparation for and prior to Substantial Completion or Owner Occupancy, installing Subcontractors shall conduct their own final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

D. In addition to removal of debris and cleaning specified in other Sections, clean interior and exterior exposed-to-view surfaces.

E. Repair, patch, replace, and touch-up marred surfaces to specified finish, to match adjacent surfaces.

F. Remove temporary protection and labels not required to remain.

G. Clean finishes free of dirt, dust, stains, films and other foreign substances.

H. Clean transparent and glossy materials to a polished condition; wash and polish glass on both faces; remove foreign substances. Polish reflective surfaces to a clear shine.

I. Remove waste, foreign matter, and debris from roofs, roof drains and drainage systems. Remove snow and ice from accesses to building.

J. Wash down completely and broom clean all paved surfaces.

K. Remove waste, debris and surplus materials from the site. Clean grounds; remove stains, spills, and foreign substances from paved areas and sweep clean. Wash or rake clean other exterior surfaces.

L. The Mechanical Subcontractor shall wash, clean and sterilize plumbing fixtures. Dust, vacuum, wash and otherwise clean unit ventilators, convectors, radiation, grilles, and registers and other mechanical work as necessary to remove stains, dust and dirt. Remove construction dirt and debris from the interior and exterior of all ductwork and air handling equipment. Provide new, clean filters for all air handling equipment just prior to final ductwork testing, adjusting and balancing.

M. The Electrical Subcontractor shall dust, vacuum, wash and otherwise clean light fixtures, lamps, lenses, reflectors and other electrical work to remove stains, dust and dirt. Clean the interior and exterior of all electrical equipment in mechanical rooms, transformer vaults, switchgear rooms and similar spaces. Replace all burned out lamps just prior to Final Completion of the Project.

N. Maintain cleaning until Final Completion of the Project. Low or no-VOC emitting material should be used for cleaning supplies.

3.06 PARTIAL OCCUPANCY

A. General Requirements: If the Owner occupies any part of the Work before the remainder of the Project is complete, the portion(s) to be occupied shall be cleaned prior to occupancy as described under Final Cleaning.

END OF SECTION

Hennepin County
North Regional Library Refurbishment

01 74 00-4
SECTION 01 74 20
CONSTRUCTION WASTE MANAGEMENT AND RECYCLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: This Section includes required recycling and recovery of the following waste materials and applies to listed waste materials produced during the Work including administrative and procedural requirements for the following:
   1. Salvaging nonhazardous demolition and construction waste.
   2. Recycling nonhazardous demolition and construction waste.
   3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:
   1. Section 02 41 20 "Selective Building Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.
   2. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.
   3. Section 02 41 13 "Selective Site Demolition" for disposition of waste resulting from site clearing and removal of above and below-grade improvements.

1.3 DEFINITIONS

A. Waste Materials are defined as large and small pieces of listed materials which are excess to contract requirements and generally include materials to be recycled and/or recovered from existing construction and items of trimmings, cuttings and damaged goods resulting from new installations, which cannot be effectively used in the Work.
   1. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
   2. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

B. Recycling is defined as the process of collecting and preparing recyclable materials and reusing them in their original form or in manufacturing processes that do not cause the destruction of recyclable materials in a manner that precludes further use.

C. Recovery is defined as any process that reclaims materials, substances, energy, or other products contained within or derived from waste on-site. It includes waste-to-energy, composting, and other processes.

D. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.
1.4 PERFORMANCE REQUIREMENTS

A. General: Waste Management Plans to be comply with B3 requirements. Contractor shall achieve end-of-Project rates for salvage/recycling of percentage by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Divert 75% construction and demolition waste from landfill. Divert at least 75% (by weight) construction, demolition, and land clearing debris from landfill disposal.
2. Reuse or return 50% of all packaging material. Reuse or return 50% of all packaging material (by weight) to suppliers or manufacturers. Reduce and recycle packaging waste associated with the construction process, and encourage manufacturers to ship their product using reusable, recyclable, returnable, or recycled content packaging.

B. Demolition Waste:
1. Asphalt paving.
2. Concrete.
3. Concrete reinforcing steel.
4. Brick.
5. Concrete masonry units.
6. Wood paneling.
7. Wood trim.
8. Structural and miscellaneous steel.
9. Rough hardware.
10. Roofing.
11. Insulation.
12. Doors and frames.
13. Door hardware.
15. Glazing.
16. Metal studs.
17. Gypsum board.
18. Acoustical tile and panels.
20. Carpet pad.
22. Plumbing fixtures.
23. Piping.
24. Supports and hangers.
27. Mechanical equipment.
28. Refrigerants.
29. Electrical conduit.
30. Copper wiring.
31. Lighting fixtures.
32. Lamps.
33. Ballasts.
34. Electrical devices.
35. Switchgear and panelboards.
36. Transformers.

C. Construction Waste:
1. Masonry and CMU.
2. Lumber.
4. Wood trim.
5. Metals.
6. Carpet and pad.
7. Gypsum board.
8. Piping.

D. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
1. Paper.
2. Cardboard.
5. Polystyrene packaging.
7. Plastic pails.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for commencement of the Work on site.

B. Qualification Data: For waste management coordinator and refrigerant recovery technician.

C. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports:

B. Delivery Receipts: Provide to the Construction Quality Manager delivery receipts for waste materials salvaged and sent to permitted waste materials processors or recyclers.


D. Concurrent with each Application for Payment, submit report.
1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

E. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
F. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

G. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

H. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

I. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable requirements of the State of Minnesota and applicable local ordinances and regulations concerning management of construction, demolition, land clearing, inert, and yard trash debris and subsequent modifications and amendments to same.

B. Disposal Sites, Recyclers, and Waste Materials Processors: Use only facilities properly permitted by the State of Minnesota and by local authorities where applicable.

C. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements.

D. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

E. Pre-Construction Waste Management Conference: Prior to beginning Work at the site, schedule and conduct a conference to review the Construction Waste Management Plan and discuss procedures, schedules and specific requirements for waste materials recycling and disposal. Discuss coordination and interface between Contractor and other construction activities. Identify and resolve problems of compliance with requirements. Record minutes of the meeting, identifying conclusions reached and matters requiring further resolution. Maintain waste management as an agenda item at future construction meetings.

1. Attendees: Contractor and related Contractor personnel associated with work of this section, including personnel in charge of the waste management program; Contractor; Architect; material suppliers where appropriate; and such additional Owner personnel as Owner deems appropriate.

2. Plan Revision: Make revisions to Construction Waste Management Plan agreed upon during the meeting and incorporate resolutions agreed to be made subsequent to the meeting. Submit revised plan to Architect for approval.

F. Implementation: Designate an on-site party responsible for instructing workers and implementing Construction Waste Management Plan. Distribute copies of Construction Waste Management Plan to jobsite foreman and each subcontractor. Include waste management and recycling in worker orientation. Provide on-site instruction on appropriate separation, handling, recycling, and recovery methods to be used by all parties at the appropriate stages of the work at the site. Include waste management and recycling discussion in pre-fabrication meetings with subcontractors and fabricators. Also include discussion of waste management and recycling in regular job meetings and job safety meetings conducted during the course of work at the site.
1.8 WASTE MANAGEMENT PLAN

A. Construction Waste Management Plan: Before start of construction, submit a construction waste management plan for approval of Contractor indicating how Contractor proposes to collect, segregate, recycle, and recover at least 75% of construction wastes and debris generated by the Work. Submit documentation indicating compliance with regulations specified under "Quality Assurance". Include a list of recycling facilities to which indicated recyclable materials will be sent for recycling. Identify materials that are not recyclable or otherwise recoverable that must be disposed of in a landfill or other means acceptable under governing State of Minnesota and local regulations. List permitted landfills and/or other disposal means to be employed.

B. Delivery Receipts: Provide to the Contractor delivery receipts for waste materials salvaged and sent to permitted waste materials processors or recyclers within 48 hours of delivery that indicate the location and name of firm accepting recyclable waste materials, types of materials, net weights of each type, date of delivery and value of materials.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. Designate an on-site party responsible for instructing workers and implementing Construction Waste Management Plan. Distribute copies of Construction Waste Management Plan to jobsite foreman and each subcontractor. Include waste management and recycling in worker orientation. Provide on-site instruction on appropriate separation, handling, recycling, and recovery methods to be used by all parties at the appropriate stages of the work at the site. Include waste management and recycling discussion in pre-fabrication meetings with subcontractors and fabricators. Also include discussion of waste management and recycling in regular job meetings and job safety meetings conducted during the course of work at the site.

B. Reporting:
   1. Periodic data processing uploaded to the Project B3 website of recycling results:
      a. Construction Waster Recycling Economics (B3 Appendix M-3b).
      b. Packaging Waste Recycling Economics (B3 Appendix M-3c).

3.2 EQUIPMENT

A. General: Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
   1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
   2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.
3.3 WASTE MANAGEMENT

A. General: Implement waste management procedures in accordance with approved Construction Waste Management Plan. Maintain procedure throughout the life of this Contract.

B. Source Separation On- or Off-Site: Either separate, store, protect, and handle at the project site all identified recyclable and recoverable waste products to prevent contamination of materials and maximize recyclability and recoverability of materials. Or mix all identified recyclable and recoverable waste products for separation off-site.

C. Arrange for the regular collection, transport from the site, and delivery to respective approved recycling centers of indicated recyclable waste materials. Maintain records accessible to the Architect for verification of construction waste materials recycling and recovery.

D. Delivery Receipts: Arrange for timely pickups from the site or deliveries to approved recycling facilities of designated waste materials to keep construction site clear and prevent contamination of materials. Keep and maintain records of deliveries to recycling facilities and pickups of waste materials at the site by others as specified above.

E. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to entity responsible for demolition and recycling.

F. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

3.4 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
   3. Store items in a secure area until installation.
   4. Protect items from damage during transport and storage.
   5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation by Contractor: Not permitted on Project site.

3.5 RECYCLING DEMOLITION WASTE

A. Contractor shall implement off-site recycling.

B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
   1. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
F. Metals: Separate metals by type.
   1. Structural Steel: Stack members according to size, type of member, and length.
   2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

H. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

I. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

J. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
   1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

K. Carpet Tile: Remove debris, trash, and adhesive.
   1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

L. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

M. Conduit: Reduce conduit to straight lengths and store by type and size.

3.6 RECYCLING CONSTRUCTION WASTE

A. Packaging:
   1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
   3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
   4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:
   1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
   2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

3.7 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
   1. Except as otherwise specified, do not allow waste materials that are to be disposed of to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Closeout procedures.
   2. Systems and equipment testing.
   3. Instructions to Owner.
   4. Clean-up.
B. Related Sections:
   1. Section 013100 – Project Management and Coordination.
   2. Section 015000 – Temporary Facilities and Controls
   3. Section 017800 – Closeout Submittals.

1.2 SUBSTANTIAL COMPLETION AND OWNER OCCUPANCY
A. Owner has urgent need to occupy Project to commence its intended use.
B. Plan an efficient, orderly and coordinated completion process including organizing, scheduling and coordinating the following:
   1. Work of contractor's own forces.
   2. Work of subcontractors.
   3. Establish firm commitments for on-time completion
   4. Owner's needs for accommodations and time to occupy project during closeout per schedule of Substantial Completion and final completion specified in Section 013216.
C. After Substantial Completion expedite completion of remaining work in an organized, efficient manner that maintains quality standards. Perform such work according to following requirements:
   1. Scheduled work in advance with Owner.
   2. Perform Work in occupied spaces when space is not in use, such as after hours in administrative areas or public spaces when public use hours are over for the day, unless otherwise approved by the Owner.
   3. When necessary, use overtime to accomplish work not able to be completed during normal work hours at no extra cost to the Owner.
   4. Perform Work in occupied areas in a manner and at such time as will not significantly interfere with, hamper or inconvenience Owner's program or functions.

1.3 PROJECT CLOSEOUT
A. Insurance: Refer to General Conditions.
   1. Upon completion of work and written acceptance by Owner, provide a Certificate of Insurance indicating specified Completed Operations insurance will be provided a minimum of one year after Owner's acceptance of entire Project.
   2. Specified Property Insurance shall be maintained until final acceptance by Owner of entire Project.
B. Supplemental Agreements: Resolve supplemental agreements prior to final payment, including adjustment of allowances.
C. Consent of Surety: Refer to General Conditions – obtain consent of surety prior to reduction in retained percentage and prior to final payment.
D. Broken Glass: Repair.
E. Guarantees - Warranties: Refer to General Conditions for general guarantee requirements.
1. In addition to general guarantee, provide written guarantees specified in technical sections of Specifications per Section 017800.

F. Test Reports and Certificates: Refer to Section 017800.

G. Retention of Records: Retain records required by law and good business practice.

H. Record Set of Drawings:
   1. Refer to General Conditions and Section 017800.
   2. Deliver record set to Architect upon Final Completion of Project.

I. Temporary Utilities:
   1. Refer to Section 015100.
   2. Remove temporary facilities and utilities as job progress permits.
   3. Read meters at times specified for transfer of services cost from Contractor to Owner for light/power.

J. Sanitary Facilities:
   1. Refer to Section 015200.
   2. Remove temporary fixtures and restore rooms as specified.

K. Temporary Facilities:
   1. Remove as work progresses and facilities are no longer needed at time acceptable to Architect.
   2. Prior to final payment, remove temporary sheds, offices, fences (including perimeter fence), barricades, surplus materials, debris and other material or items not part of Project.

L. Extra Materials: Refer to Section 017800

M. Construction Cores and Keys:
   1. At time of Substantial Completion, just prior to occupancy, replace construction cores and install permanent cores in locks.
   2. Thereafter, access to spaces will be provided by the Owner.

N. Identification of Equipment:
   1. Prior to Substantial Completion, provide identification tags or plates, or other identification means, as specified under Technical Sections of Specifications, such as at valves, panelboards and similar items.
   2. Apply directions on plates for circuit data and similar information.

1.4 SYSTEMS AND EQUIPMENT TESTING

A. Test equipment and systems to demonstrate each system and piece of equipment is installed and operating properly.

B. Provide a written record of tests and results per Section 017800.

C. After operation and testing of systems, instruct Owner's representatives with Architect's representative present.

1.5 INSTRUCTIONS TO OWNER

A. Provide instructions before final payment is made. Submit evidence that instruction/maintenance manuals were delivered to and were acceptable to Owner.

B. Requirements herein supplement specific requirements provided under individual specification sections.

C. Collect information and data so complete manuals are provided in sufficient time to permit review prior to time for final payment. Refer also to Section 017800.

D. Provide qualified representatives of Contractor or subcontractors to give explanations and instructions.

E. Provide instruction manuals per Section 017800 to be used and reviewed during instructions.
F. Thoroughly and properly instruct the Owner in use, operation, care and maintenance of Project, especially various systems and equipment installed under Contract. Give instructions methodically and carefully. Cover various phases of work and in sufficient detail so Owner fully understands entire Project.

G. Orient and familiarize designated Owner Representatives with locations, methods, materials, uses and operation of systems and equipment, as well as specialized materials installed under Contract.

H. Instruct and demonstrate to the Owner regarding full use, sequence or function and similar information to fully acquaint Owner in proper use, care and control of equipment, systems and devices installed under Contract.

I. Precautionary Measures and Dangers of Misuse.
   1. Specifically explain precautions and dangers of misuse.
   2. Establish specific and agreed upon periods of time with the Owner, adequate to thoroughly present pertinent information.
   3. Owner will record length of time and number of days spent on these instructions.

J. Refer to Section 013100 for additional information and data for maintenance manual such as coordination drawings.

1.6 CLEAN-UP

A. Refer to General Conditions for cleaning requirements during construction.

B. Clean materials and equipment. Remove (haul away) debris, cartons, crates, surplus materials. C. Maintain work neat and orderly.

D. Definitions
   1. Thorough Cleaning:
      a. Thorough cleaning required unless otherwise specified.
      b. Remove dust, dirt, debris, laitance, grease, oil, stains, discolorations, droppings, markings, and other soil or foreign matter or substance.
      c. Remove labels except labels specifically designated to remain as part of listed, rated or labeled item.
      d. Use appropriate methods such as sweeping, scrubbing, mopping, washing, dusting vacuuming so surface is completely clean and streak free.
   2. Broom Clean: Remove visible dirt or dust from surface with a new, high quality, clean broom by thoroughly and properly sweeping or brooming so no dust or dirt is visible on surface.

E. Perform general "final" cleaning prior to inspection for Substantial Completion and occupancy. Plan, organize and coordinate cleaning to avoid working in spaces once cleaned. Coordinate timely cleaning with Architect especially for cleaning of glass.

F. Clean entire Project including, but not limited to:
   1. Cleaning required under each Section.
   2. Remove accumulated dust, dirt and debris.
   3. Materials, equipment or other items.
   4. Glass - both sides, interior and exterior, and mirrors.

G. Electrical Subcontractor Cleaning: Includes but is not limited to:
   1. Normally occupied areas, service areas, passages and corridors and similar spaces.
   2. Interiors of cabinets, panelboards and other equipment.
   3. Other work under contract needing cleaning.

H. Mechanical Subcontractor Cleaning: Includes but is not limited to:
   1. Remove filters used during construction and install permanent new filters.
   2. Ductwork.
   3. Fixtures and fittings.
   4. Insides of convectors.
   5. Unit heaters or similar units
6. Radiation.
7. Piping and equipment in equipment rooms
8. Other work under contract needing cleaning.

I. "Broom Clean" is allowed in following areas:
   1. Tunnels, shafts, air shafts and air plenums not constructed of ductwork
   2. Similar areas.
   3. Floors in equipment rooms (including rooms such as electrical equipment rooms)
      a. Except also wash floors and apply final coat of sealer if specified.

J. Floors (including concrete) must be free of stains and discoloration

K. Hardware: Adjust and polish as needed

L. Perform other cleaning as required to turn the Project over to the Owner in new, well maintained
   condition, ready for full use and occupancy.

M. Clean areas made dirty by work done after Substantial Completion so building is clean as specified
   prior to Final Completion.

1.7 FINAL ACCEPTANCE AND FINAL PAYMENT

A. Final payment will not be made until final acceptance inspection, completion of punch list items and
   final sign-off by Owner and Architect.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Closeout submittals.
      2. Warranties and guarantees.
      3. Test reports and certificates.
      4. Extra materials.
      5. Maintenance manuals.
      6. Record drawings and specifications.

   B. Related Sections:
      1. Section 013300 - Submittal Procedures.
      2. Section 017700 - Closeout Procedures.

1.2 WARRANTIES AND GUARANTEES
   A. Provide written guarantees specified in technical sections of Specifications.
   B. Where guarantee terms are included in Specifications or a specific guarantee is referenced, submit guarantee in specified form.
   C. Submit guarantees prior to final payment.
   D. Submit a checklist of required guarantees, by section numbers.

1.3 TEST REPORTS AND CERTIFICATES
   A. Provide test reports and certificates required in technical sections prior to final payment.
   B. Provide a written record of systems and equipment testing and results.
   C. Provide a check list of required reports and certificates, by Specifications sections.

1.4 EXTRA MATERIALS
   A. Prior to final completion, deliver extra materials specified in various technical sections.
   B. Do not allow materials to "collect" in various parts of Project. Deliver to Owner together.
   C. Obtain receipt for specified extra materials. Without such evidence of delivery, no credit will be given for fulfilling specified requirements.
   D. Provide a checklist of specified extra materials.

1.5 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS
   A. Coordinate submittals from Section 013300 that will be needed to fulfill following requirements.
   B. Provide operating instruction data and maintenance manuals in accordance with Section 017700 - Closeout Procedures.
   C. Organize information by classes or types of equipment and systems as follows:

      1. Manuals shall consist of neatly edited and typed instruction manuals (in 1 hard copy and 2 electronic copies on a disk) to explain use, function and control of equipment, materials and systems. Printed information shall include:
         a. Warranties and guarantees.
b. Common errors made, which will "abuse" equipment or system
c. Use, function and control of equipment and systems
d. Clean installation data and pamphlets (not to be left at equipment but included in manuals)
e. Instructions and explanations.
f. Cleaning instructions.
g. Wiring and piping diagrams.
h. Various types of maintenance procedures.
i. Lubrication data and schedules.
j. Maintenance materials to be used.
k. Maintenance information.
l. Maintenance instructions with frequency.
m. Other maintenance information.
n. Adjustment and repair data.
o. Parts list with numbers and recommended parts for Owner's stock.
p. Names, addresses, and telephone numbers parts distributor.
q. Names, addresses, and telephone numbers of appropriate service organizations for various items and equipment.

2. Manuals shall include systems and equipment as specified, but not limited to following information:
   a. Heating and ventilating equipment
   b. Fan units
c. Air conditioning
d. Controls for mechanical systems
e. Alarm systems
f. Electrical distribution systems
g. Operating equipment of general construction
h. Mechanical and electrical work
i. Power operated doors
j. Other similar systems and equipment.

1.6 RECORD SET OF DRAWINGS AND SPECIFICATIONS

A. Provide record set of Drawings and Specifications to Architect at completion of Contract.
   1. Refer to General Conditions for general requirements.
   2. Refer to Section 013300 - Submittal Procedures for posted (updated) job site contract documents.

B. During construction, maintain clean set of Drawings and Specifications for sole purpose of recording changes to Contract.

C. Mark record set methodically as work progresses, clearly and neatly, in color.

D. Include information cut and pasted into appropriate location of documents to reference change, adjustment, or clarification. Type of information to be recorded on record set includes but is not limited to:
   1. Addendum items sent during bidding
   2. Changes, deviations or revisions made, except minor or non-critical dimensions, including those made by Change Order or Supplementary Instructions.
   3. Accepted submittals including shop drawings, product data and samples.
   4. Omissions, including work omitted by accepted alternates.
   5. Dimensioned locations of major or main utility lines, such as main conduit runs, piping mains and similar work.
   7. Additions to the work.
   8. Changes in significant details.
   9. Changed footing or other elevations.
10. Locations of electrical home run boxes, including circuit numbers and panel designations for each box.
11. Coordination drawings.
12. Changes in locations of panelboards, outlets, drains, piping, openings, dampers and similar features.
13. Other similar data.

PART 2 PRODUCTS
Not Used.

PART 3 EXECUTION
Not Used.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory manuals.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

B. Related Requirements:
1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect and AE consultants will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit on digital media acceptable to Architect by email to Architect. Enable reviewer comments on draft submittals.
2. Submit three paper copies. Architect will return two copies.
C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and AE Consultants will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form at least 15 days before commencing demonstration and training. Architect and AE Consultants will return copy with comments.

   1. Correct or revise each manual to comply with Architect's and AE consultants comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and AE Consultants comments and prior to commencing demonstration and training.

E. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

   1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
   2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

   1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

       a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
       b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

   2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.


5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

   1. Title page.
   2. Table of contents.

B. Title Page: Include the following information:

   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name and contact information for Contractor.
   6. Name and contact information for Architect.
   7. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
   8. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."
1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:

1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

   a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record drawings to ensure correct illustration of completed installation.
   1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and
telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.
   4. Miscellaneous record submittals.

B. Related Requirements:
   1. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
   2. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one set(s) of marked-up record prints.
   2. Number of Copies: Submit copies of record Drawings as follows:
      a. Initial Submittal:
         1) Submit one paper-copy set(s) of marked-up record prints.
         2) Submit PDF electronic files of scanned record prints and one of file prints.
         3) Submit record digital data files and one set(s) of plots.
         4) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
      b. Final Submittal:
         1) Submit one paper-copy set(s) of marked-up record prints.
         2) Submit record digital data files and three set(s) of record digital data file plots.
         3) Plot each drawing file, whether or not changes and additional information were recorded.
1.4 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Accurately record information in an acceptable drawing technique.
   c. Record data as soon as possible after obtaining it.
   d. Record and check the markup before enclosing concealed installations.
   e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.
   c. Depths of foundations.
   d. Locations and depths of underground utilities.
   e. Revisions to routing of piping and conduits.
   f. Revisions to electrical circuitry.
   g. Actual equipment locations.
   h. Duct size and routing.
   i. Locations of concealed internal utilities.
   j. Changes made by Change Order or Construction Work Change Directive.
   k. Changes made following Architect's written orders.
   l. Details not on the original Contract Drawings.
   m. Field records for variable and concealed conditions.
   n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.

4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2. Format: Annotated PDF electronic file with comment function enabled.

3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.

4. Identification: As follows:
a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Architect.
e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as scanned PDF electronic file(s) of marked-up paper copy of Specifications.

1.6 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as scanned PDF electronic file(s) of marked-up paper copy of Product Data.

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
B. Format: Submit miscellaneous record submittals as scanned PDF electronic file(s) of marked-up miscellaneous record submittals.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.8 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's and Construction Manager's reference during normal working hours.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION
SECTION 01 81 13

SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements and procedures for compliance with certain Minnesota B3 requirements.
   1. Other Minnesota B3 requirements depend on product selections and may not be specifically identified as Minnesota B3 requirements. Compliance with Minnesota B3 requirements will be used as one criterion to evaluate substitution requests and comparable product requests.
   2. Specific Minnesota B3 requirements are also included in other Sections.

B. Related Requirements:
   1. Section 01 31 00 – Project Management and Coordination.
   2. Section 01 50 00 – Temporary Facilities and Controls.
   3. Section 01 56 00 - Indoor Air Quality Control Procedures.
   5. Section 01 91 13 - General Commissioning Requirements

1.3 REGULATORY REQUIREMENT

A. In 2001, The Minnesota Legislature required the Departments of Administration and Commerce, with the assistance of other agencies, to develop sustainable building design guidelines mandatory for all new buildings receiving funding from the bond proceeds fund after January 1, 2004. In 2008, this legislation was expanded to include development of sustainable building guidelines mandatory for all major renovations receiving funding from the bond proceeds fund after January 1, 2009. The legislation defined major renovations as at least 10,000 square feet and including the replacement of the mechanical, ventilation, or cooling system of the building or a section of the building. According to the legislation, the guidelines for both new buildings and major renovations must:
   1. Exceed the state energy code by at least 30 percent.
   2. Focus on achieving the lowest possible lifetime costs.
   3. Encourage continual energy conservation improvements.
   4. Include air quality and lighting standards.
   5. Create and maintain a healthy environment.
   6. Facilitate productivity improvements.
   7. Specify ways to reduce material costs.
   8. Consider the long-term operating costs of the building including the use of renewable energy sources and distributed electric energy generation that uses a renewable source or natural gas or a fuel that is as clean or cleaner than natural gas.

1.4 DEFINITIONS

   1. Definitions that are a part of the Minnesota B3 apply to this Section.

B. Recycled Content Building Materials: Materials that contain not less than 50 percent combined recycled content (postconsumer and preconsumer) or contain not less than 25 percent combined recycled content and that comply with requirements for recyclable building materials and building components.
C. Recyclable Building Materials and Building Components: Materials and components that can be recycled into the same or another material with a recovery rate of not less than 30 percent or that are recyclable through an established, nationally available, closed-loop manufacturer's take-back program.

D. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 250 miles (400 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

E. Bio-Based Materials: One of the following:
   1. Materials with bio-based content of not less than 75 percent when tested according to ASTM D 6866.
   2. Wood and wood products that are labeled in accordance with the American Forest & Paper Association's Sustainable Forestry Initiative.
   3. Wood and wood products that are certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004.
   4. Wood and wood products that are certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.
   5. Salvaged or reused wood products.

F. Indigenous Materials: Manufactured regionally within a radius of 250 miles (400 km) of Project site to specified qualifications, or are manufactured within the State of Minnesota and contain products from state-sponsored, approved, or acknowledged recycling programs.

G. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Review Minnesota B3 requirements and action plans for meeting requirements.

1.6 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect regarding Minnesota B3 requirements that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures. Document responses as informational submittals.

1.7 ACTION SUBMITTALS

A. General: Submit additional sustainable design submittals required by other Specification Sections.

B. Sustainable design submittals are in addition to other submittals.
   1. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record copy of compliance with indicated Minnesota B3 requirements instead of separate sustainable design submittal. Mark additional copy "B3 Sustainable Design Submittal".

C. Minnesota B3 Documentation Submittals:
   1. Material Selection: Product data for used, recycled, recyclable, bio-based, and indigenous materials showing compliance with requirements. Tabulate mass, volume, or cost for building materials used in the Project and indicate those that are used, recycled, recyclable, bio-based, or indigenous. Include summary of building materials tabulation, showing compliance with requirement and the following:
      a. Receipts for used materials, indicating sources and mass, volume, or cost as applicable.
      b. Product data and certification letter from product manufacturers for recyclable materials. Include statement indicating mass, volume, or cost as applicable.
1.8 INFORMATIONAL SUBMITTALS

A. Action Plans: Submit the following action plans within 30 days of date established for the Notice to Proceed, indicating how requirements will be met.
   1. Construction Waste Management Plan:
      a. Comply with Section 01 74 19 "Construction Waste Management and Disposal."
   2. Indoor-Air Quality (IAQ) During Construction Plan:
      a. Comply with Section 01 56 00 - Indoor Air Quality Control Procedures.
   3. Material Emissions and Pollutant Control Plan:
      a. Comply with Section 01 56 00 - Indoor Air Quality Control Procedures.
   4. Material Selection Plan:
      a. List of proposed materials. Tabulate anticipated mass, volume, or cost for proposed building materials and indicate those that are used, recycled, recyclable, bio-based, or indigenous. Include summary of proposed building materials tabulation, showing compliance with requirement.

B. Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction activities with action plans.

1.9 QUALITY ASSURANCE

A. Coordinator: Engage an experienced Accredited Professional to coordinate requirements. Coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Provide products and procedures necessary to comply with requirements in this Section for material selection and for material emissions and pollutant control. Although other Sections may specify some requirements for material selection and for material emissions and pollutant control, the Contractor shall provide additional materials and procedures necessary to comply with requirements.

2.2 PERFORMANCE REQUIREMENTS

A. At least 10% of the total (weight or value) of the materials used in the project are recycled content. Pro-rate cost or weight by each material’s recycled content amount. Materials that contain a minimum weighted average of 20% post-consumer recycled content material, OR, a minimum weighted average of 50% pre-consumer (post-industrial) recycled content material are eligible.
   1. Only half the cost or weight of pre-consumer (post-industrial) recycled content may be counted (i.e. multiply pro-rated values for pre-consumer recycled weight or volume by 0.5 when calculating their contribution to the completion of this guideline).
B. Use renewable, bio-based raw materials for 5% of the total (weight or value) of all products used in the project. Qualifying materials must be either: (a) residues from the processing of renewable, bio-based materials; OR (b) grown or harvested under a recognized sustainable management system. Programs that do not require third-party certification may be included. At a minimum, the management system must be subject to audit by the authority responsible for the system.

1. For solid wood products, OSB, plywood and other engineered wood products, materials certified under one of the following systems can be fully counted by weight or value.
   a. Forest Stewardship Council.
   b. Sustainable Forestry Initiative.
   c. Canadian Standards Association Sustainable Forestry Management.
   d. Property and Environment Research Center.

2. For bio-based content materials other than those listed above such as particleboard, cementitious panels or other material not rated by the above organizations, pro-rate the percentage contributing to satisfaction of this guideline by the bio-based content listed by the manufacturer. Particleboard without manufacturer provided wood content percentages may be considered 75% bio-based content.

C. Use materials manufactured regionally within a radius of 250 miles (400 km) of Project site to specified qualifications, or are manufactured within the State of Minnesota and contain products from state-sponsored, approved, or acknowledged recycling programs. If only a portion of a material or product complies with this requirement, only that portion shall be considered indigenous.

2.3 MATERIAL SELECTION

A. Refer to technical and products specifications for materials and product options to comply with performance requirements of Minnesota B3.

PART 3 - EXECUTION

3.1 Not Used.

END OF SECTION
SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY
A. Section includes commissioning process requirements for systems, assemblies, and equipment.
B. Contractor shall be familiar with all parts of Section 019113 and the Commissioning Plan issued by
the Commissioning authority (CxA). Contractor shall execute all commissioning responsibilities
assigned to them in the Contract documents.
C. Related Sections:
   1. Division 22 Plumbing.
   3. Division 26 Electrical.

1.2 DEFINITIONS
A. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product
selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and
guidelines. The document includes both narrative descriptions and lists of individual items that
support the design process.
B. Commissioning (Cx): The process of ensuring that systems are designed, installed, functionally
tested and performing in conformity with the Owner’s Project Requirements and that the building
operator has received complete equipment and systems documentation and training.
C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources,
and documentation requirements of the commissioning.
D. Commissioning Authority (CxA): The entity identified by the Project Manager to lead, monitor,
coordinate and report on project commissioning activities. The commissioning provider may be the
project A/E (most common), an independent third party or Owner.
E. Construction Checklists (CC): A quality control verification process performed by the installer as
building assemblies, components, equipment and systems are being installed which documents
that the materials, installation procedures, interfaces with other trades, start-up, testing and
operation are correct, complete, in compliance with contract documents and manufacturer’s
recommendations and are ready for functional performance testing.
F. Functional Tests (FT): Contractor testing of installed building assemblies, components, equipment,
systems and interfaces which confirms correct performance through all operating modes and
compliance with contract documents and manufacturer’s recommendations.
H. Systems, Subsystems, Equipment, and Components: Where these terms are used together or
separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 COMMISSIONING TEAM
A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the
entity he or she represents, explicitly organized to implement the commissioning process through
coordinated action. The commissioning team shall consist of, but not be limited to, representatives
of each Subcontractor, including Project superintendent and subcontractors, installers, suppliers,
and specialists deemed appropriate by the CxA.
B. Members Appointed by Owner:
   a. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
   b. Representatives of the facility, user and operation & maintenance personnel.
   c. Architect and engineering design professionals.

1.4 OWNER’S RESPONSIBILITIES

A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities and equipment training.

B. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA for use in developing the commissioning plan and each Subcontractor.

1.5 ARCHITECT (A/E)

A. Attend the commissioning scoping meeting and other selected commissioning team meetings.

B. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted.

C. Provide design narrative documentation requested by the CxA.

D. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.

E. Prepare or facilitate and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.

F. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.

G. Attend: Within 10 months of substantial completion and prior to completion of warranty period, CxA shall coordinate and facilitate a substantial completion review meeting. The intent of the meeting will be to review the project design, construction, turnover, operation and warranty issues. Contractor is required to have key project personnel in attendance and participating in the review for the purpose of making future project delivery improvements.

1.6 CONTRACTOR’S RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
   1. Attend commissioning team meetings held on a monthly basis.
   2. Integrate and coordinate commissioning process activities with construction schedule.
   3. Review and accept construction checklists provided by the CxA.
   4. Complete paper construction checklists as work is completed.
   5. Review and accept commissioning process test procedures provided by the Commissioning Authority.
   6. Complete commissioning process test procedures, involve manufacturer where required to demonstrate.
   7. Evaluate deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
   8. Cooperate with the CxA for resolution of issues recorded in the Action Log.
   9. Provide requested documents to the CxA for project documentation.
  10. Coordinate the training of owner personnel.
  11. Ensure that Subs execute seasonal or deferred functional testing, witnessed by the CxA.
  12. Attend: Within 10 months of substantial completion and prior to completion of warranty period, a substantial completion review meeting.
1.7 CXA'S RESPONSIBILITIES

A. Organize and lead the commissioning team. B. Provide commissioning plan.
C. Convene commissioning team meetings.
D. Provide Project-specific construction checklists and commissioning functional test procedures to subcontractors.
E. Verify the execution of commissioning process activities using random sampling. Verification will include, but is not limited to, equipment submittals, construction checklists, functional tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Action Log.
F. Prepare and maintain the Action Log.
G. Observe and approve the training of the Owner’s operating personnel.
H. Prepare and maintain completed construction checklist log.
I. Coordinate: Within 10 months of substantial completion and prior to completion of warranty period, a substantial completion review meeting.
J. Compile test data, inspection reports, and certificates; include them in the commissioning process report.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Provide equipment required to perform startup, checkout and testing. Equipment shall be calibrated within the past year and in accordance with the manufacturer’s recommendations.

PART 3 EXECUTION

3.1 MEETINGS

A. Each contractor is required to attend meetings related to commissioning (pre-construction, construction progress, etc.) and have personnel requested by CxA in attendance to facilitate quality control and coordinate commissioning efforts.
B. The CxA will present an overview of the project’s commissioning process at the initial commissioning team meeting. The commissioning team members will be identified and their responsibilities reviewed.
C. At subsequent meetings, contractors are to provide a review of project progress, a report on the status of issues, commissioning tasks and scheduling for future commissioning tasks.

3.2 SCHEDULING

A. Reference General Requirements in Division 01 for Lead Contractor responsibilities for scheduling. Each contractor shall provide the Lead Contractor a detailed schedule and regular updates of commissioning tasks for incorporation into the project schedule.

3.3 ACTION LOG
A. Each contractor is responsible for completing action items in a timely manner that are noted in the Action Log as their responsibility. Timely response and successful completion are a requirement to avoid withholding of payment.

3.4 **CXA SITE VISITS**
A. Commissioning is a team effort requiring the cooperation of all parties. Contractors are to proactively carry out their commissioning responsibilities and are to assist the CxA during site visits in performing commissioning tasks. This includes providing access to and demonstrating the installation, operation, and testing of commissioned systems; responding to CxA requests for information; carrying out proactive and corrective actions; and accurate reporting on system status and conditions.

3.5 **CONSTRUCTION CHECKLISTS**
A. The construction checklists are a formalized means to provide individual workers the criteria for a successful installation, adherence to the construction documents and to easily track construction progress.
B. Each assembly, component, equipment, system and interface to be commissioned shall be verified by the installer at the site while work is underway and documented on the construction verification checklists. The contractor is responsible for successfully completing installations, documenting this on the construction checklist forms and correcting all deficiencies.
C. Contractor shall periodically review the construction verification schedule with the CxA allowing advance notice of activities of 5 business days so that the CxA may witness as deemed necessary. If CxA identifies more than a 10% discrepancy rate during confirmation of construction verification, the contractor shall correct all deficiencies and revalidate all items covered by that checklist and resubmit new checklists. The cost of reconfirmation of construction verification due to equipment or construction deficiencies is the responsibility of the contractor and subject to deductive change order at Owner’s discretion. Correction of deficiencies and revalidation are the responsibility of the contractor and are not subject to time extensions or delay claims.
D. Complete the construction checklists for this project and submit to the CxA for review and comment. The construction checklist must be sent to the CxA a minimum of one week prior to final scheduling of functional tests. Contractor should make multiple copies of the blank test forms as needed for duplicate items.

3.6 **FUNCTIONAL TESTING**
A. Complete the functional performance test procedures included on the functional performance test forms on this project. Coordinate with Owner, A/E and CxA so they may witness and document test results.
B. Contractors are responsible for completion and coordination of their work with all trades prior to testing, preplanning testing procedures, performing equipment start-up, insuring necessary staff and resources are on hand and expediting testing. This includes completion of testing and balancing by the HVAC contractor required for successful functional performance testing. Failure to complete or coordinate work, preplan or have staff and resources available to carry out testing will result in retesting. Submit completed construction checklist forms and testing adjusting and balancing (TAB) report to CxA for review prior to scheduling testing for witnessing. It is required also that the BAS contractor needs to coordinate in order for them to complete all of their work
C. Contractor shall coordinate functional performance testing with OWNER, the A/E and CxA and notify them 5 business days prior to testing so that they may witness and document the test results. All contractors involved with specific assemblies, components, equipment, systems and interfaces shall have qualified installers and technicians present at the same time working together to perform testing and demonstrate correct performance through all operating and failure modes and compliance with contract documents and manufacturer’s recommendations.
D. CxA shall establish sampling protocol and at the time of testing select sample test locations for identical pieces of equipment. Where simulation of conditions or altering of setpoints or values is required to achieve an operating or failure mode for testing, the contractor must receive CxA approval.

E. With Owner's oversight, the CxA is responsible for witnessing functional performance testing and recording the results and deficiencies. Correct minor deficiencies during testing. Deficiencies that cannot be corrected during testing will be documented and subject to retest. Retesting will continue until no deficiencies remain.

F. Retesting is required when testing cannot be successfully completed. Deficiencies requiring retesting include:
   1. Incomplete work and/or coordination with others
   2. Inadequate preparation of systems for testing
   3. Inadequate preplanning
   4. Inadequate staff, equipment, tools or resources for testing
   5. Material, equipment or construction deficiencies
   6. Incomplete or failed test due to reasons under the Contractor's responsibility

G. The cost of retesting is the responsibility of the contractor and subject to deductive change order at Owner's discretion. Correction of deficiencies and retesting are the responsibility of the contractor and are not subject to time extensions or delay claims.

END OF SECTION
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SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Fire-suppression equipment and piping demolition.
   3. Equipment installation requirements common to equipment sections.
   4. Painting and finishing.
   5. Supports and anchorages.

1.3 DEFINITIONS
A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, and spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
F. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 BASIS-OF-DESIGN
A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufactures listed in the specification other than the basis-of-design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.5 SUBMITTALS
A. Product Data: For the following:
   1. Mechanical sleeve seals.
   2. Escutcheons.
B. Welding certificates.
C. Grooved joint couplings and fittings shall be referred to on drawings and product submittals, and be identified by the manufacturer’s listed model or series designation.
1.6 QUALITY ASSURANCE

A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. All grooved couplings, and fittings, valves and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

E. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

G. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

H. Comply with requirements of Owner's insurance underwriter for submittals, approvals, materials, installation, inspections, and testing.

1.7 GUIDELINES, CODES AND STANDARDS

A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.

B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.9 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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Common Work Results for Fire Suppression

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PART 2 PRODUCTS

2.1 MANUFACTURERS
   A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
      1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS
   A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
   B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
      1. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA-13. Couplings shall be fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping of bolt pads at specific torque ratings are not permitted. Installation-ready, for direct stab installation without field disassembly.
      2. Flexible Type: Use in locations where vibration attenuation and stress relief are required.

2.3 JOINING MATERIALS
   A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
   B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
      1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
         a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
         b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
      2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
   C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
   D. Grooved Joint Lubricants: Lubricate gaskets in accordance with the manufacturer’s published installation instructions, using lubricant compatible with the gasket elastomer and fluid media.
   E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
   F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
   G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
PART 3 EXECUTION

3.1 PREPARATION

A. Obtain current fire-hydrant flow test results from the local authority having jurisdiction. Use results for system design calculations required in "Quality Assurance" Article.

3.2 FIRE-SUPPRESSION DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   4. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 SERVICE-ENTRANCE PIPING

A. Connect fire sprinkler and standpipe piping to water-service piping for service entrance to building. Comply with requirements for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Verify final equipment locations for roughing-in.
M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.5 PIPING JOINT CONSTRUCTION
A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
F. Grooved Joints: Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer, and shall be verified as suitable for the intended service. A factory-trained field representative (direct employee) of the mechanical joint manufacture shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products. A distributor's representative is not considered qualified to conduct the training.
G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
H. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 PAINTING
A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES
A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 SEALANTS


END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 SLEEVES
A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company (The).
   4. Pipeline Seal and Insulator, Inc.
   5. Proco Products, Inc.
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Holdrite.
B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.
2.4 GROUT
B. Characteristics: Non-shrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION
A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes in walls.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas, pipe chases, or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION
A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION
A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
C. Secure nailing flanges to concrete forms.
D. Using grout, seal the space around outside of sleeve-seal fittings.
3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs above Grade:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

2. Interior Partitions:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

END OF SECTION
SECTION 21 05 18
ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 ESCUTCHEONS
A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES
A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following hangers and supports for fire suppression systems piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Fastener systems.
   5. Pipe stands.
   6. Pipe positioning systems.
   7. Equipment supports.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment support.
   2. Division 21 Section "Expansion Fittings and Loops for Fire Suppression Piping" for pipe guides and anchors.
   3. Division 21 Section "Vibration and Seismic Controls for Fire Suppression Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Incorporated
B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS
A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS
A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Powder-actuated fastener systems.
   3. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Pipe stands. Include Product Data for components.
   4. Equipment supports.

C. Welding certificates.
1.6 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to [AWS D1.1, "Structural Welding Code--Steel."] [AWS D1.4, "Structural Welding Code--Reinforcing Steel."] [ASME Boiler and Pressure Vessel Code: Section IX.]
B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS
A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
B. Manufacturers:
   1. AAA Technology & Specialties Company, Incorporated (www.aaatech.com)
   2. Anvil International (www.anvilintl.com)
   4. B-Line Systems, Incorporated; a division of Cooper Industries (www.cooperindustries.com)
   5. Carpenter & Paterson, Incorporated; a division of Cooper Industries (www.carpenterandpaterson.com)
   6. Empire Industries, Incorporated (www.empireindustries.com)
   7. ERICO/Michigan Hanger Company (www.ericom.com)
  10. PHD Manufacturing, Incorporated (www.phdmfg.com)
  11. PHS Industries, Incorporated
  13. Tolco Incorporated; a division of Cooper Industries (www.cooperindustries.com)
C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 TRAPEZE PIPE HANGERS
A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS
A. Description: MFMA-4, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
B. Manufacturers:
   1. B-Line Systems, Incorporated; a division of Cooper Industries (www.cooperindustries.com)
   2. ERICO/Michigan Hanger Company (www.erico.com)
   3. Power-Strut Division; Tyco International, Ltd. (www.powerstrut.com)
   4. Thomas & Betts Corporation (www.tnb.com)
   5. Tolco Incorporated; a division of Cooper Industries (www.cooperindustries.com)
   6. Unistrut Corporation; a part of Atkore International (www.unistrut.us)

C. Coatings: Manufacturer’s standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Incorporated (www.us.hilti.com)
      b. ITW Ramset/Red Head (www.ramset.com)
      c. MKT Fastening, LLC (www.mktfastening.com)
      d. Powers Fasteners (www.powers.com)

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. B-Line Systems, Incorporated; a division of Cooper Industries (www.cooperindustries.com)
      b. Empire Industries, Incorporated (www.empireindustries.com)
      c. Hilti, Incorporated (www.us.hilti.com)
      d. ITW Ramset/Red Head (www.ramset.com)
      e. MKT Fastening, LLC (www.mktfastening.com)
      f. Powers Fasteners (www.powers.com)

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Attachments to metal roof decks will not be permitted.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated; install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 30.
2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
3. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
4. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
5. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

G. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
4. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

H. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

I. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

J. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs greater than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured.
   3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary inserts, bolts, nuts, washers, and other accessories.


G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 CLEANING

A. Clean exposed hangers and supports located finished spaces.

END OF SECTION
SECTION 21 05 53
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 PRODUCTS

2.1 STENCILS
A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.2 VALVE TAGS
A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.3 WARNING TAGS
   A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
      1. Size: Approximately 4 by 7 inches.
      2. Fasteners: Brass grommet and wire.
      3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 EXECUTION

3.1 PREPARATION
   A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
   A. Install or permanently fasten labels on each major item of fire suppression equipment.
   B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION
   A. Stenciled Pipe Label Option: Install stenciled pipe, complying with ASME A13.1, on each piping system.
      1. Identification Paint: Red.
      2. Stencil Paint: white.
   B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      1. Near each valve and control device.
      2. Near each branch connection.
      3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
      4. At access doors, manholes, and similar access points that permit view of concealed piping.
      5. Near major equipment items and other points of origination and termination.
      6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   C. Pipe Label Color Schedule:
      1. Fire Suppression Piping:
         a. Background Color: Red.

3.4 VALVE-TAG INSTALLATION
   A. Install tags on valves and control devices in piping systems. List tagged valves in a valve schedule.
   B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
      1. Valve-Tag Size and Shape:
         c. Low-Pressure Compressed Air: 1-1/2 inches round.
         d. High-Pressure Compressed Air: 1-1/2 inches round.
2. Valve-Tag Color: Red

3.5 WARNING-TAG INSTALLATION
A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pipes, fittings, and specialties.
   2. Specialty valves.
   4. Pressure gages.

B. Protection Limits:
   1. Provide 100 percent coverage for spaces within the limits of construction.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Domestic water piping.
   2. Compressed air piping.
   3. HVAC hydronic piping.
   4. Items penetrating finished ceiling include the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.

B. Qualification Data: For qualified Installer and professional engineer.
C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
   1. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

D. Welding certificates.

E. Grooved joint couplings and fittings shall be referred to on drawings and product submittals and shall be identified by the manufacturer’s style or series designation. Trade names and abbreviations are not acceptable.

F. Fire-hydrant flow test report.

G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

H. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. All grooved joint couplings, fittings, valves, and specialties shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for fittings, couplings, valve bodies, etc., shall include a cast date stamp for quality assurance and traceability.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
1.10 PROJECT CONDITIONS
A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of sprinkler service.
   2. Do not proceed with interruption of sprinkler service without Construction Manager's and Owner's written permission.

PART 2 PRODUCTS
2.1 PERFORMANCE REQUIREMENTS
A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
C. Delegated Design: Engage a qualified professional engineer or NICET Certified Designer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
   1. Static and residual water pressure and water flow data shall be obtained from the local authority having jurisdiction.
   2. Minimum Pipe Sizes: Pipes shall not be smaller than sizes indicated on the drawings for connection to water supply piping, standpipes, and branches from standpipes to sprinklers.
   3. Maximum Water Velocity: Design water velocities shall not exceed 20 (FPS) feet per second in any fire protection piping.
   4. Sprinkler system design shall be approved by authorities having jurisdiction.
      a. Margin of Safety for Available Water Flow and Pressure: 20 percent, including losses through water-service piping, valves, and backflow preventers.
      b. Sprinkler Occupancy Hazard Classifications:
         1) Automobile Parking Areas: Ordinary Hazard, Group 1.
         2) Building Service Areas: Ordinary Hazard, Group 1.
         3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
         4) General Storage Areas: Ordinary Hazard, Group 1.
         5) Libraries except Stack Areas: Light Hazard.
         6) Library Stack Areas: Ordinary Hazard, Group 2.
         7) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
         8) Office and Public Areas: Light Hazard.
   5. Minimum Density for Automatic-Sprinkler Piping Design:
      a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
      b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
      c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
      d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
      e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
      f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
   6. Maximum Protection Area per Sprinkler: According to UL listing.
   7. Maximum Protection Area per Sprinkler: Revised the following to suit requirements of authorities having jurisdiction for specific project requirements.
      a. Office Spaces: 120 sq. ft.
      b. Storage Areas: 130 sq. ft.
      c. Mechanical Equipment Rooms: 130 sq. ft.
      d. Electrical Equipment Rooms: 130 sq. ft.
      e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.3 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized and Black Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

A. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.


C. Galvanized and Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.


F. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick, ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.
   b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.


1. Welding Filler Metals: Comply with AWS D10.12M/D10/12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Corcoran Piping System Co. (www.american-marsh.com)
   c. Shurjoint Piping Products. (www.shurjoint.com)
   d. Smith-Cooper International (www.smithcooper.com)
   e. Tyco Fire & Building Products LP. (tyco-fire.com)
   f. Victaulic Company. (www.victaulic.com)

2. Pressure Rating: 175 psig minimum.


4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and ASTM A449 bolts and nuts.
   a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA-13. Installation ready rigid coupling for direct stab installation without field disassembly. Couplings shall be fully installed at visual pad-to-pad offset contact. Tongue and recess type couplings, which require the use of a torque wrench to achieve the exact required gap between housings, are not permitted.
   b. Flexible Type: Use in locations where vibration attenuation and stress relief are required.
2.4 SPECIALTY VALVES
A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:
   2. High-Pressure Piping Specialty Valves: 250-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Victaulic Company (www.victaulic.com)
      b. Viking Corporation (www.vikingcorp.com)
   3. Design: For vertical installation.
   4. Internal components shall be replaceable without removing the valve from the installed position.
   5. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages and fill-line attachment with strainer.
   6. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
   7. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
   8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

2.5 SPRINKLER PIPING SPECIALTIES
A. Branch Outlet Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International (www.anvilintl.com)
      b. Shurjoint Piping Products (www.shurjoint.com)
      c. Tyco Fire & Building Products (tyco-fire.com)
      d. Victaulic Company (www.victaulic.com)
   5. Type: Mechanical-tee and -cross fittings.
   6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
   7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
   8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co. Inc. (www.reliablesprinkler.com)
      b. Tyco Fire & Building Products (tyco-fire.com)
      c. Victaulic Company (www.victaulic.com)
   4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkhart Brass Manufacturing Co, Inc. (www.elkhartbrass.com)
   b. Fire-End & Croker Corporation (www.croker.com)
   c. Potter Roemer LLC (www.potterroemer.com)
2. Standard: UL 199.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector’s Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Victaulic Company (www.victaulic.com)
   b. Viking Corporation (www.vikingcorp.com)
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Aegis Technologies, Inc. (aegistechnologiesinc.com)
   b. CECE, LLC (www.cecaforge.com)
   c. Corcoran Piping System Co.
   d. Merit Manufacturing
5. Size: Same as connected piping.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fivalco Inc. (www.fivalcoinc.com)
   b. Flex-Head Industries, Inc. (www.flexhead.com)
   c. Gateway Tubing, Inc. (www.gatewaytubing.com)
   d. Victaulic Company (www.victaulic.com)
3. Type: Flexible hose for connection to sprinkler, and with open-gate bracket for connection to ceiling grid. The bracket shall allow installation before the ceiling tile is in place.
5. Size: Same as connected piping, for sprinkler.
6. The drop shall include a UL approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for [(4) bends at 31" length] [(5) bends at 36" length] [(8) bends at 48" length] [(10) bends at 60" length] [(12) bends at 72" length].

7. Union joints shall be provided for ease of installation.

2.6 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co. Inc (www.reliablesprinkler.com)
   b. Victaulic Company (www.victaulic.com)
   c. Viking Corporation (www.vikingcorp.com)

B. Sprinkler body shall be integrally cast with a hex shaped wrench boss to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss. (Sprinklers shall not contain rubber O-rings.)

C. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

D. Pressure Rating for Residential Sprinklers: 175-psig maximum.

E. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

F. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.

G. Automatic Sprinklers with Heat-Responsive Element:
   1. Early-Suppression, Fast-Response Applications: UL 1767
   2. Nonresidential Applications: UL 199
   3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

   1. Nominal Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8

I. Sprinkler Finishes: Refer to specific project requirements:
   1. Chrome plated
   2. Bronze

J. Special Coatings: Refer to specific project requirements:
   1. Wax
   2. Lead
   3. corrosion-resistant paint

K. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Chrome-plated steel, one piece, flat
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

L. Sprinkler Guards:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co. Inc (www.reliablesprinkler.com)
      b. Victaulic Company (www.victaulic.com)
      c. Viking Corporation (www.vikingcorp.com)
   2. Standard: UL 199.
   3. Type: Wire cage with fastening device for attaching to sprinkler.

M. Guards and escutcheons shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
2.7 PRESSURE GAGES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AGF Manufacturing Inc. (www.testanddrain.com)
   2. AMETEK, Inc. (www.ametek.com)
   3. Ashcroft, Inc. (www.ashcroft.com)
   4. Brecco Corporation
   5. WIKA Instrument Corporation (www.wika.us)
B. Standard: UL 393.
C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
D. Pressure Gage Range: 0- to 250-psig minimum
E. Label: Include "WATER" label on dial face.

PART 3 EXECUTION

3.1 PREPARATION
A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION
A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
G. Install sprinkler piping with drains for complete system drainage.
H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
I. Install alarm devices in piping systems.
J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
K. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
L. Fill sprinkler system piping with water.
M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints in accordance with the manufacturer's published instructions. A factory trained representative (direct employee) shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
D. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.5 SPRINKLER INSTALLATION
A. Sprinklers shall be located in a regular pattern, perpendicular and parallel with building lines, in perfect alignment with other ceiling components such as lights, air diffusers, grilles, and speakers.

B. Where sprinkler locations are indicated on Architectural Drawings and the coverage is inadequate, provide additional sprinklers heads located as directed by the Architect. Additional sprinklers (in excess of NFPA minimum requirements) may be required for aesthetics.
   1. Acoustical Ceiling Tile: Sprinklers shall be located in the center of tile; fully within a 4-inch diameter circle at the center of the tile. Locations shall be in the center of a 2-ft. x 2-ft. tile or in a 2 ft. x 2 ft. half of a 2 ft. x 4-ft. tile.
   2. Sprinklers shall be located no closer than 4 inches from any ceiling edge or from any other ceiling component.
   3. Sprinkler locations shall be reviewed and accepted by the Architect before any piping is fabricated or installed.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

D. Do not install sprinklers that have been dropped or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

E. Sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

3.6 IDENTIFICATION
A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL
A. Perform the following tests and inspections
   1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
   4. Energize circuits to electrical equipment and devices.
   5. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 CLEANING
A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.
3.9 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   3. Standard-weight or Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   4. Standard-weight or Schedule 30, galvanized-steel pipe with roll-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   5. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 8, shall be one of the following:
   1. Standard-weight or Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   2. Standard-weight or Schedule 30, galvanized-steel pipe with roll-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   3. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   4. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.10 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Concealed sprinklers.
   4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Concealed Sprinklers: Rough brass, with factory-painted cover plate. Cover plate cover shall be selected by architect.
   2. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Plumbing demolition.
   5. Equipment installation requirements common to equipment sections.
   6. Painting and finishing.
   7. Supports and anchorages.

1.3 BASIS-OF-DESIGN

A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufacturers listed in the specification other than the basis-of-design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.4 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.
1.5 SUBMITTALS
A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
B. Welding certificates.
C. Equipment Startup Reports.
D. Coordination Drawings: Submit one copy for the engineers use. Division 22 coordination drawings will not be returned.
   1. Detail major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
      a. Planned piping layout, including valve and specialty locations and valve-stem movement.
      b. Clearances for installing and maintaining insulation.
      c. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
      d. Equipment and accessory service connections and support details
      e. Exterior wall and foundation penetrations.
      f. Fire- and smoke-rated wall and floor penetration.
      g. Sizes and locations of required concrete equipment curbs and bases.
      h. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
      i. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
      j. Access door and panel locations.

1.6 QUALITY ASSURANCE
A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.
B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
1.8 COORDINATION
A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
D. Coordinate plumbing equipment installation with other building components.
E. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
F. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
G. Coordinate connection of plumbing equipment and systems with building electrical systems.

1.9 GUIDELINES, CODES AND STANDARDS
A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.
B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS
A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS
A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Company
      b. Dresser Industries, Incorporated; DMD Division
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Division
      d. JCM Industries
      e. Smith-Blair, Incorporated
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement- joint end.
   1. Manufacturers:
      a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO Incorporated
      b. NIBCO, Incorporated; Chemtrol Division.

E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      b. Fernco, Incorporated.
2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Company
      b. Central Plastics Company.
      c. Epco Sales, Incorporated
      d. Watts Industries, Incorporated; Water Products Division

D. Dielectric Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Incorporated
      b. Calpico, Incorporated
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Incorporated
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Calpico, Incorporated
      b. Lochinvar Corporation.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corporation.
      b. Precision Plumbing Products, Incorporated
      c. Sioux Chief Manufacturing Company, Incorporated
      d. Victaulic Company of America.

PART 3 EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   4. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA’s "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Non-pressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

K. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

L. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

M. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

N. PEX Piping Joints: Join according to ASTM F 1807.

O. Steel-Piping Grooved Joints: Roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

P. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in steel piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric flanges to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install plumbing equipment according to the equipment manufacturer’s installation instructions and as indicated on the drawings. Resolve conflicting instructions, with the architect before mounting equipment.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. Refer to equipment shop drawings for rough-in locations; do not scale drawings.

3.6 PAINTING
A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES
A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES
A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 SEALANTS
A. Comply with joint-sealant materials and applications specified in Section 078400 “Firestopping,” Section 078443 “Fire-resistant Joint Sealants,” Section 079000 “Joint Protection,” and Section 092900 “Gypsum Board: Acoustical sealants.”

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Variable Frequency Motor Controller Bypass

C. VFC Filtering

D. Related Requirements:
   1. Section 260500 “Common Work Results for Electrical” for basic installation requirements.
   2. Section 260526 “Grounding and Bonding for Electrical Systems” for basic materials and installation of grounding.
   3. Section 262200 “Low-Voltage Transformers” for transformers to serve VFC’s.
   4. Section 262813 “Fuses” for installation in VFC’s and bypass units.
   5. Section 262816 “Enclosed Switches and Circuit Breakers” for disconnects and overcurrent protection of VFC’s.

1.2 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).
B. CPT: Control power transformer.
C. DDC: Direct digital control.
D. EMI: Electromagnetic interference.
E. LED: Light-emitting diode.
F. NC: Normally closed.
G. NO: Normally open.
H. OCPD: Overcurrent protective device.
I. PID: Control action, proportional plus integral plus derivative.
J. PWM: Pulse Width Modulation
K. RFI: Radio-frequency interference.
L. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.

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Variable-Frequency Motor Controllers (VFCs)
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.

7. Include mounting and attachment details.

8. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

9. Include diagrams for power, signal, and control wiring.

10. Detailed installation drawings including:
   a. Control terminals, designation, and locations
   b. Power circuit diagram identifying disconnects, bypass disconnect, filters or isolation transformer, and motor.
   c. Internal electrical wiring and control circuit diagram
   d. Wiring of auxiliary devices and optional inputs.
   e. Interconnection to harmonic filter traps, line reactors, and dV/dT filters.

11. Furnish a technical brochure or matrix detailing standard VFC features.
   a. Motor horse power and amperage rating.
   b. Power factor at full load.
   c. Input power characteristics.
   d. Full load Efficiency.
   e. Control interface requirements.
   f. Status display system.
   g. Options not listed in specifications.

12. Exceptions and variations from the specification.

13. Include steady state and fault current ratings.

14. Filter characteristics:
   a. Dimensional drawings with installed weight for each size.
   b. Power input characteristics.
   c. Wiring diagram

C. Contractor shall obtain all the VFC’s from a single manufacturer for the entire Project. Coordinate between Division 23 prior to submitting shop drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Required working clearances and required area above and around VFCs.
   2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
   3. Show support locations, type of support, and weight on each support.
   4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Product Certificates: For each VFC from manufacturer.


E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
      b. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
      c. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE
A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
B. Provide Variable Frequency Controllers suitable for operating with NEMA Design B induction motors. VFC's shall be compatible with standard 3 phase high efficiency motors.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING
A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. VFC Warranty Period: Five years from date of Substantial Completion.
   2. Filter Warranty Period: Three years from date of Substantial Completion.
PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Variable Frequency Motor Controller Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. ABB Low-Voltage HVAC Drives
   2. Danfoss Inc; Danfoss Drives Div.

C. Harmonic Trap Filters, dV/dT, Filters, and Input Line Reactor Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trans Coil Inc.
   2. MTE
   3. Myron Zucker
   4. Schaffner

2.2 VFC SYSTEM DESCRIPTION AND RATINGS

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: Constant torque or variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 66 Hz, with torque constant as speed changes; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 100 percent speed and greater than 80 percent at 50 percent speed.
   5. Minimum Power Factor: 95 percent at 100 percent speed and greater than 90 percent at 25 percent speed.
   6. Bus capacitance voltage ratings
      a. 208-240V VFC's shall have a minimum bus voltage capacitance of 400 VDC.
b. 460-480V VFC’s shall have a minimum bus voltage capacitance of 800 VDC.

7. IGBT ratings
   a. 208-240V VFC’s shall be equipped with IGBT’s that have a minimum $V_{ce}$ rating of 600V.
   b. 460-480V VFC’s shall be equipped with IGBT’s that have a minimum $V_{ce}$ rating of 1200V.

8. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.

9. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).


11. Altitude Rating: Not exceeding 3300 feet (1000 m).

12. Audible noise shall not exceed 85 dBA measured at a point 3 feet from the VFC.


14. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

15. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.

16. Speed Regulation: Plus or minus 10 percent.

17. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

18. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Converter Section
   1. Utilize six-pulse full wave diode or PWM bridge design to convert fixed voltage and frequency AC line power to fixed DC voltage.
   2. Operation of the converter section shall be unaffected by phase rotation.
   3. Input shall have MOVs (Metal Oxide Varistors) for surge protection.

H. DC Bus Section
   1. DC bus shall include a minimum 5% integrated DC link reactors to minimize harmonic distortion.
   2. DC bus shall have a passive capacitive filter to minimize ripple and maximize power-loss ride through.
   3. Provide balance discharge resistors to equalize charge voltage and permit safe discharge of capacitors upon loss of power.

I. Inverter Section
   1. Utilize isolated-gate bipolar transistors (IGBTs) to convert DC bus voltage to three phase, variable frequency, and sinusoidal coded PWM waveform to control the motor. Six step and current source drives are not acceptable.
   2. PWM switching frequencies (Carrier Frequency): Selectable; 1.0 to 12 kHz. Factor set the carrier frequency at 3 kHz.
   3. VFC shall be capable of skipping over minimum of two critical frequencies to prevent the VFC from operating the load continuously at unstable speeds. VFC shall accelerate or decelerate through these ranges, but not be allowed to operate consistently in these ranges.

J. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

K. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

L. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.
M. Self-Protection and Reliability Features:
   1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
   3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   5. Inverter overcurrent trips.
   6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC over- temperature and motor-overload alarm and trip; settings selectable via the keypad.
   7. Critical frequency rejection, with three selectable, adjustable deadbands.
   8. Instantaneous line-to-line and line-to-ground overcurrent trips.
   11. Short-circuit protection.

N. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

O. Power- Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

P. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

Q. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

R. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

2.3 PERFORMANCE REQUIREMENTS
   A. If audible motor noise created by the VFC exceeds 5 dB of the motor noise generated when the motor is directly connected to line power through an across the line starter, the VFC supplier shall remedy the situation at no cost.

2.4 CONTROLS AND INDICATION
   A. Electrically isolate the following circuit systems from the main power circuits:
      1. Internal control circuiting regulating DC bus voltage and inverter output frequency.
      2. Circuitry supplying various microprocessors, controllers, sensors, etc., which provide the VFC’s operational and safety features.
   B. Provide devices which will limit the following operational parameters:
      1. Permit field adjustment of minimum and maximum output frequency. The range shall be adjustable from 4 Hz to 60 Hz.
      2. Permit field adjustment of the acceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range acceleration rates initially at 60 seconds.
      3. Permit field adjustment of the deceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range deceleration rate at 60 seconds.
C. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.

D. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

E. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

F. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).
   11. Heat sink temperature
   12. Operating hours (with reset function)
   13. Megawatt hours (with reset function)

G. VFC Monitoring and Alarming
   1. The VFC controller shall have the ability to display the following alarms and notifications at the VFC display as well as the relay the to the building automation system via communications interface.
      a. Status indicators
         1) On/Off status
         2) Input power Status
         3) Input power fault
         4) Over-current fault
         5) Ground fault
         6) Under-voltage
         7) Over-voltage
         8) Over-temperature fault
         9) Motor over-load fault
        10) Motor under-load fault
11) DC braking
12) Emergency off
13) Retry
14) Restart

b. Alarms
1) Over-voltage pre-alarm
2) Over-current pre-alarm
3) Under-voltage
4) Overheat pre-alarm
5) Overload pre-alarm
6) Communications Error
7) Tuning Error
8) Point setting alarm
9) Clear enabling indication
10) Emergency Stop Enabling indication
11) Setting Error Alarm
12) Momentary power loss slowdown
13) Lower-limit time-out stop
14) VFD in bypass

c. Faults
1) Over-current (start up)
2) Over-current (Acceleration, Deceleration, and Running)
3) U-phase short
4) V-phase short
5) W-phase short
6) Over-voltage (Acceleration, Deceleration, and Running)
7) Under-voltage
8) Over-frequency
9) Under-frequency
10) Over-heat
11) Over-heat (external)
12) Over-torque
13) Inverter overload
14) Motor overload
15) Ground Fault
16) Input phase failure
17) Output phase failure
18) Sequence error
19) Speed error
20) V/Hz control error
21) Communications error
22) Logic voltage error
23) Self-diagnostics alarm
24) VFD in bypass

d. VFC shall be equipped of automatic reset and restart circuit which will restart the motor 20 seconds after self-protection shut down. The VFC shall attempt no more than 5 automatic restarts. Each successive attempt shall occur at least 120 seconds after the last.

H. Control Signal Interfaces (I/O):
1. Electric Input Signal Interface:
   a. A minimum of [two] <Insert number> programmable analog inputs: [0- to 10-V dc] [4- to 20-mA dc] [Operator-selectable "x"- to "y"-mA dc] <Insert signal parameters>.
   b. A minimum of [six] <Insert number> multifunction programmable digital inputs.
2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
4. VFC shall be equipped with a 120 VAC or 24 VDC safety circuit for fire alarm system shutdown.
5. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20- mA dc), which can be configured for any of the following:
   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).
   g. <Insert indication>.
6. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120- V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

I. Communications Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
   1. Hardwired Points:
      b. Control: On-off operation.
   2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.
      a. Coordinate with Division 23 and provide signal compatibility for a direct serial communications interface with:
         1) Verify existing control system in existing building.

2.5 LINE CONDITIONING AND FILTERING

A. Provide UL listed Filters for the application.
B. Filters shall be located adjacent to the VFC or contained in a common enclosure as the VFC it is serving.
C. Filter enclosures shall be meet the same requirements as specified for VFC’s.
D. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.
E. Input Line Conditioning
   1. Provide a 5% input line reactor on the input of all VFC’s greater than 50 HP in addition to any internal line reactors and filters.
   2. Provide harmonic filters on the input of all VFC’s serving motors greater than 50 HP
      a. Provide contactor within filter to disconnect capacitors from line power to the VFC when signal is received from the VFC. VFC shall be programed to disconnect capacitors at 25% load and energize capacitors at 30% load.
b. Provide contactor to bypass entire filter when VFD has been bypassed. Provide interlock between bypass switch and contactor.

3. VFC disconnecting means shall disconnect power to input filter and reactors.

F. Output Filtering: Provide dV/dt filters for all locations where conductors between the motors and VFC are 75 feet or longer.

G. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

1. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) for motors less than 40 HP, Reduced-voltage (autotransformer) for motors 40 HP and larger type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 50 VA.

   a. Solid-State Overload Relays:
      1) Switch or dial selectable for motor-running overload protection.
      2) Sensors in each phase.
      3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      5) Analog communication module.
   b. NC isolated overload alarm contact.
   c. External overload, reset push button.
2.7 ENCLOSURES
A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 3R.
   4. Other Wet or Damp Indoor Locations: Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."
C. Internal cooling fans and filter shall be provided where required to maintain drive operating temperature.
D. Internal heating elements shall be provided where required to maintain drive operating temperature.
E. Provide lifting provisions for units weighing more than 80 pounds.
F. All units shall be provided with a grounding lug.
G. The enclosure shall have a through-the-door interlocking handle with padlocking provisions.
H. Wall units shall be provided with necessary mounting brackets.

2.8 ACCESSORIES
A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
B. Reversible NC/NO bypass contactor auxiliary contact(s).
C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
E. Supplemental Digital Meters:
   1. Elapsed-time meter.
   2. Kilowatt meter.
F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.9 SOURCE QUALITY CONTROL
A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. The VFC manufacturer shall obtain information about any critical speeds, which must be locked out in the VFC controls to avoid noise and vibration caused by harmonic resonance in the mechanical system.

B. Contractor shall coordinate final VFC locations with VFC manufacturer and mechanical equipment layouts.

3.3 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 66 inches (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Separate line, load, and control conductors in separate continuous metallic conduits. Provide ferrous metallic shielding around each VFC conductor group when conductors are installed in wire way or gutter. The contractor may submit shielded conductor cable assemblies designed for operation with VFC’s.
E. Provide all power connection including wiring associated with any isolation transformer disconnect reactors, filters, and any accessories. Include power wiring from the VFC to the motor, as well as all grounding connections.

F. Where it is not possible to install motors within the sight of the VFC provide a disconnect switch at the motor as required by the NEC or required by the specifications. Provide an interlocking connection between the disconnect at the motor and the VFC to prevent the VFC from operating in a no load situation.

G. All connections to the VFC shall be with a minimum 18 inches of seal tight flexible conduit, allowing for ease of maintenance.

H. Provide separate grounding conductor to the VFC and between the VFC and the motor in addition to the conduit system.

I. Temperature control contractor shall provide all control connections to the VFC from any sensors or control devices.

J. Provide separate overload protection for each motor when a VFC serve multiple motors.

K. Install fuses in each fusible-switch VFC.

L. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

M. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

N. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

O. Comply with NECA 1.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.5 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.
B. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
   5. Test each motor for proper phase rotation.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
   10. Test voltage distortion. Voltage distortion shall not exceed 3% and the line notch depth shall not exceed 10% as defined in IEEE Standard 519-1992 “IEEE Guide for Harmonic control and Reactive Compensation of Static Power Converters.” Provide necessary harmonic filters or line reactors to achieve these values. A written report shall be provided to the engineer showing all test results.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. At a minimum perform the following operational checks and provide a report to the engineer that each VFC has met the following checks:
      a. Maximum output frequency = 60 Hz ± 1 Hz.
      b. Minimum output frequency = 4 Hz ± 1 Hz.
      c. Control signal setpoint ± 10% of that specified.
      d. Simulated power outage and control system reaction.
      e. Manual bypass switch over and operation tested.
      f. Starting into an already rotating motor load and determine if self-protection of the VFC is adequate.
      g. Acceleration rate from a dead stop to full speed at the maximum and minimum rate adjustment.
h. Deceleration rate from full speed to dead stop at maximum and minimum rate adjustment.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

F. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs. The manufacturer shall arrange for and conduct a user training session(s) at the Project site, explaining the operation of each type of VFC package. Allow for a minimum 4 hours of training for the first VFC and 1 hours of training for each additional VFC up to a maximum of 15 hours. The supplier shall notify the Engineer of the training session at least 1 week prior to the scheduled date so the Engineer can make arrangement to attend.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 SLEEVES
A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 GROUT
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION
A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

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Sleeves and Sleeve Seals for Plumbing Piping

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C. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

D. Acoustical Interior Wall Penetrations: Maintain indicated STC rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with acoustical sealant materials.

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE
   1. Interior Partitions:
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves

END OF SECTION
SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following general-duty valves:
      1. Copper-alloy ball valves.
      2. Ferrous-alloy butterfly valves.
      5. Spring-loaded, lift-disc check valves.
      7. Cast-iron globe valves.
      8. Chainwheel actuators.
   B. Related Sections include the following:
      1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
      2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
      3. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS
   A. The following are standard abbreviations for valves:
      1. CWP: Cold working pressure.
      2. EPDM: Ethylene-propylene-diene terpolymer rubber.
      3. NBR: Acrylonitrile-butadiene rubber.
      4. PTFE: Polytetrafluoroethylene plastic.
      5. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS
   A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE
   A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
   B. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable water service. Valves for domestic water must be third party certified.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Prepare valves for shipping as follows:
      1. Protect internal parts against rust and corrosion.
      2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL
A. Refer to Part 3 “Valve Applications” Article for applications of valves.
B. Bronze Valves: NPS 3 and smaller with threaded ends, unless otherwise indicated.
C. Ferrous Valves: NPS 4 and larger with flanged ends, unless otherwise indicated.
D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
F. Valve Actuators:
   1. Handwheel: For valves other than quarter-turn types.
   2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
   3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
G. Extended Valve Stems: On insulated valves.
I. Valve Grooved Ends: AWWA C606.
J. Solder Joint: With sockets according to ASME B16.18.
   1. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves. Do not use solder joint ball valves.
K. Threaded: With threads according to ASME B1.20.1.
L. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES
A. Manufacturers:
   1. Two-Piece, Copper-Alloy Ball Valves:
      a. Conbraco Industries, Incorporated; Apollo Division
      b. Crane Company; Crane Valve Group.
c. Grinnell Corporation.
d. Hammond Valve.
e. Jamesbury, Incorporated
f. Jomar International, LTD.
g. Legend Valve & Fitting, Incorporated
h. Milwaukee Valve Company.
i. Nexus Valve Specialties.
j. NIBCO Incorporated
k. Watts Industries, Incorporated; Water Products Division

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Threaded Bronze body with standard-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem. Example: Conbraco #70-100-03

2.4 BRONZE CHECK VALVES

A. Manufacturers:

1. Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:
   a. Cincinnati Valve Company
   b. Crane Company; Crane Valve Group.
   c. NIBCO Incorporated.
   d. Walworth Company

2. Bronze, Vertical Lift Check Valves with Nonmetallic Disc:
   a. Grinnell Corporation.
   b. Kitz Corporation of America.
   c. Milwaukee Valve Company.
   d. NIBCO Incorporated.

3. Bronze, Swing Check Valves with Metal Disc:
   a. American Valve, Incorporated
   b. Cincinnati Valve Company
   c. Crane Company; Crane Valve Group.
   d. Grinnell Corporation.
   e. Hammond Valve.
   f. Kitz Corporation of America.
   g. Legend Valve & Fitting, Incorporated
   h. Milwaukee Valve Company.
   i. NIBCO Incorporated.
   j. Powell, Wm. Company
   k. Red-White Valve Corporation
   l. Walworth Company
   m. Watts Industries, Incorporated; Water Products Division

B. Bronze Check Valves, General: MSS SP-80.

C. Type 2, Class 125, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat. Example: NIBCO #T-480 or #S-480

D. Type 2, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat. Example: NIBCO #T-480 or #S-480

E. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat. Example: NIBCO #T-413 or #S-413

F. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat. NIBCO #T-433 or #S-433
2.5 CAST-IRON GLOBE VALVES

A. Manufacturers:
   1. Type I, Cast-Iron Globe Valves with Metal Seats:
      a. Cincinnati Valve Company
      b. Crane Company; Crane Valve Group.
      c. Grinnell Corporation.
      d. Hammond Valve.
      e. Kitz Corporation of America.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Powell, Wm. Company
      i. Red-White Valve Corporation
      j. Walworth Company


C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats. Example: NIBCO #F-718-B

D. Type I, Class 250, Cast-Iron Globe Valves: Gray-iron body with bronze seats. Example: NIBCO #F-768-B

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   1. Shutoff Service:
      a. NPS 3 and smaller: Ball valves.
   2. Throttling Service:
      a. NPS 3 and smaller: Ball valves.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
C. Domestic Water Piping: Use the following types of valves:
   1. Ball Valves, NPS 3 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
   2. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, horizontal or vertical, bronze.

D. Select valves, except wafer and flangeless types, with the following end connections:
   1. For Copper Tubing, NPS 3 and Smaller: Threaded ends.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Fiberglass pipe hangers.
   4. Metal framing systems.
   5. Fiberglass strut systems.
   6. Thermal-hanger shield inserts.
   7. Fastener systems.
   8. Pipe stands.
   9. Pipe positioning systems.
  10. Equipment supports.
B. Related Sections:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   3. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Fiberglass strut systems.
   4. Pipe stands.
   5. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS
A. Welding certificates.

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Hangers and Supports for
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1.7 QUALITY ASSURANCE
A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS
A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel
B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel

2.2 TRAPEZE PIPE HANGERS
A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS
A. Clevis-Type, Fiberglass Pipe Hangers:
   1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
   2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel
B. Strap-Type, Fiberglass Pipe Hangers:
   1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
   2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel

2.4 METAL FRAMING SYSTEMS
A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
      c. Flex-Strut Inc.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut Corporation; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
4. Channels: Continuous slotted steel channel with in turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel
7. Metallic Coating: Hot-dipped galvanized

2.5 FASTENER SYSTEMS
A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS
A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS
A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION
A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

3.2 EQUIPMENT SUPPORTS
   A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
   B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
   C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS
   A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING
   A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
   B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING
   A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
      1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
   B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE
   A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
   B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
   C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
   D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
   E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.
   F. Use fiberglass pipe hangers and fiberglass strut systems attachments for hostile environment applications.
   G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
   H. Use padded hangers for piping that is subject to scratching.
   I. Use thermal-hanger shield inserts for insulated piping and tubing.
   J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
      1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
      2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
3. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
4. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
5. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION
SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   5. Stencils.
   6. Valve tags.
   7. Warning tags.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION
A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS
A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for equipment.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.
B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service, and showing flow direction, complying with ANSI A13.1.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self Adhesive Pipe Labels: Printed plastic with contact type, permanent adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Direction Arrows: Integral with piping system service lettering to accommodate both Flow directions, or as separate unit on each pipe label to indicate flow direction.

E. Lettering Size: At least 1-1/2 inches high.

2.3 PLASTIC TAPE

A. General: Manufacturer’s standard color coded pressure sensitive (self adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2 inch wide tape markers for pipes 6 inches or larger and provide 3/4 inch wide tape markers for pipes less than 6 inches.

C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.4 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS
   A. Valve Tags: Stamped or engraved 1-1/2-inch diameter, with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
      1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
      2. Fasteners: Brass wire-link or beaded chain; or S-hook.
   B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
      1. Valve-tag schedule shall be included in operation and maintenance data.
      2. For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of rigid plastic or extruded aluminum, with clear plastic glazing.

2.7 WARNING TAGS
   A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
      1. Size: Approximately 4 by 7 inches.
      2. Fasteners: Brass grommet and wire.
      3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 EXECUTION

3.1 PREPARATION
   A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
   A. Install or permanently fasten labels on each major item of mechanical equipment.
   B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION
   A. Piping Color-Coding: Painting of piping is specified in Division 09 Section.
   B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe, complying with ASME A13.1, on each piping system.
      1. Identification Paint: Use for contrasting background.
   C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

D. Pipe Label Color Schedule:
1. Domestic Water Piping:
   a. Background Color: Green.
2. Sanitary Waste and Storm Drainage Piping:
   a. Background Color: Green.

3.4 VALVE-TAG INSTALLATION
A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
   2. Valve-Tag Color:
      b. Hot Water: Natural.
   3. Letter Color:

3.5 VALVE SCHEDULE WITH FRAME INSTALLATION
A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION
A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 CEILING GRID AND ACCESS PANEL LOCATION TAGS
A. Provide adhesive stickers or tags on ceiling grids or access panels indicating locations of domestic water valves.
B. Sticker or tags shall have 1/4-inch text size.

END OF SECTION
SECTION 22 07 19
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Roof drains and rainwater leaders.
   5. Supplies and drains for handicap-accessible lavatories and sinks.
B. Related Sections:
   1. Section 220716 "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.

1.5 QUALITY ASSURANCE
A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
C. Coordinate installation and testing of heat tracing.
1.8 SCHEDULING
A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000-Degree Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Super-Stik.
B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Thermokote V.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.

   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      d. Speedline Corporation; Polycr VP Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS
A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

2.5 SEALANTS
A. Joint Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

2.6 FACTORY-APPLIED JACKETS
A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 PROTECTIVE SHIELDING GUARDS
A. Protective Shielding Pipe Covers:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Engineered Brass Company.
      b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
      c. McGuire Manufacturing.
      d. Plumberex.
      e. Truebro; a brand of IPS Corporation.
      f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Truebro; a brand of IPS Corporation.
      b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer’s written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer’s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer’s recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
   1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of polyolefin pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
D. Insulation Installation on Valves and Pipe Specialties:
   1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11 FIELD-APPLIED JACKET INSTALLATION
A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.
B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.12 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE
A. Domestic Cold Water:
   1. NPS 2 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.
   2. NPS 2-1/2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.
B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.
   2. NPS 1-1/2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

C. Storm-water and Overflow:
   1. Insulate down comers from roof drain bodies, horizontal piping to the connection at main vertical piping, and 5 feet down the vertical piping from the connection. Insulate down comers from overflow roof drain bodies and piping within 5 feet of the overflow roof drains.
   2. Insulate all exposed overflow storm water piping.
   3. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

E. Condensate and Equipment Drain Water below 60 Degrees F:
   1. Extend insulation to the connection to main sanitary or storm water piping, and all piping within 10 feet of the drain (including sanitary or storm water main piping).
   2. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Degrees F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE
A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Exposed:
   1. Piping located within 8 feet of the floor; less than 200 degrees F: PVC: 30 mils thick.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
   2. Encasement for piping.
B. Related Requirements:
   1. Section 221113 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS
A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS
A. System purging and disinfecting activities report.
B. Field quality-control reports.

PART 2 PRODUCTS

2.1 PIPING MATERIALS
A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS
A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
F. Copper Pressure-Seal-Joint Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkhart Products Corporation.
      b. NIBCO Inc.
      c. Viega.
2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

G. Copper-Tube, Extruded-Tee Connections:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. T-Drill Industries Inc.
   2. Description: Tee formed in copper tube according to ASTM F 2014.

2.3 PIPING JOINING MATERIALS
A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.
B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Solder Filler Metals: ASTM B 32, lead-free alloys.
D. Flux: ASTM B 813, water flushable.
E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS
A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.
B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cascade Waterworks Manufacturing.
      b. Dresser, Inc.; Piping Specialties Products.
      c. Ford Meter Box Company, Inc. (The).
      d. JCM Industries.
      e. Romac Industries, Inc.
      f. Smith-Blair, Inc.; a Sensus company.
      g. Viking Johnson.

2.5 DIELECTRIC FITTINGS
A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
      b. Central Plastics Company.
      c. Matco-Norca.
      d. Watts; a division of Watts Water Technologies, Inc.
      e. Wilkins; a Zurn company.
   3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

B. Dielectric-Flange Insulating Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
   2. Non-conducting materials for field assembly of companion flanges.
   4. Gasket: Neoprene or Phenolic.
   5. Bolt Sleeves: Phenolic or polyethylene.

C. Dielectric Nipples:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elster Perfection Corporation.
      b. Grinnell Mechanical Products; Tyco Fire Products LP.
      c. Matco-Norca.
      d. Precision Plumbing Products, Inc.
      e. Victaulic Company.
   3. Electroplated steel nipple complying with ASTM F 1545.
   4. Pressure Rating and Temperature: 300 psig at 225 deg F.
   5. End Connections: Male threaded or grooved.

PART 3 EXECUTION

3.1 EARTHWORK
   A. Comply with requirements in Division 31 for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION
   A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
   B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
   C. Install shutoff valve immediately upstream of each dielectric fitting.
   D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
   E. Install domestic water piping level and plumb.
   F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

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G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping to permit valve servicing.

K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

L. Install piping free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

O. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOIN CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION
A. Install transition couplings at joints of dissimilar piping.
B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.5 DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 3 and Smaller: Use dielectric couplings or nipples.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.6 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support vertical piping and tubing at base and at each floor.
C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
E. Install supports for vertical copper tubing every 10 feet.

3.7 CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION
   A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
   B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections:
      1. Piping Inspections:
         a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
         b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
            1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
            2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
         c. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
         d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
      2. Piping Tests:
         a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
         b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
         c. Leave new, altered, extended, or replaced domestic water piping uncovered and unsealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
         d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
         e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
         f. Prepare reports for tests and for corrective action required.
   B. Domestic water piping will be considered defective if it does not pass tests and inspections.
   C. Prepare test and inspection reports.
3.10 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
   8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints NPS 4 and larger, unless otherwise indicated.
C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 3 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast-or wrought-copper solder-joint fittings; and soldered joints.
   2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 3 and smaller. Use butterfly, with flanged ends for piping NPS 4 and larger.
   2. Throttling Duty: Use ball valves for piping NPS 3 and smaller. Use butterfly valves with flanged ends for piping NPS 4 and larger.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Vacuum breakers.
   2. Balancing valves.
   3. Strainers.
   4. Hose bibbs.
   5. Drain valves.
   7. Air vents.
   8. Flexible connectors.
B. Related Requirements:
   1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
   2. Section 221116 "Domestic Water Piping" for water meters.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For domestic water piping specialties.
   1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES
A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS
A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.
2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
   d. FEBCO; a division of Watts Water Technologies, Inc.
   e. Rain Bird Corporation.
   f. Toro Company (The); Irrigation Div.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
5. Inlet and Outlet Connections: Threaded.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. TACO Incorporated.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Ball valve with two readout ports and memory-setting indicator.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO Inc.
h. Red-White Valve Corp.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y- Pattern Strainers:
   1. Pressure Rating: 125 psig minimum unless otherwise indicated.
   2. Body: Bronze for NPS 2 and smaller; cast iron [with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and] for NPS 2-1/2 and larger.
   3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   4. Screen: Stainless steel with round perforations unless otherwise indicated.

2.6 HOSE BIBBS

A. Hose Bibbs:
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
13. Include operating key with each operating-key hose bibb.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 400-psig minimum CWP.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   8. Inlet: Threaded or solder joint.
B. Gate-Valve-Type, Hose-End Drain Valves:
2. Pressure Rating: Class 125.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:
1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
5. Drain: NPS 1/8 side outlet with cap.

2.8 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Precision Plumbing Products, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products.
   i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.9 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
5. Size: [NPS 3/8] [NPS 1/2] minimum inlet.

B. Welded-Construction Automatic Air Vents:
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.

2.10 FLEXIBLE CONNECTORS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.

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4. Flex Pression, Ltd.
5. Flex-Weld Incorporated.
6. Hyspan Precision Products, Inc.
7. Mercer Gasket & Shim, Inc.
8. Metraflex, Inc.
9. Proco Products, Inc.
10. TOZEN Corporation.
11. Unaflex.Universal Metal Hose; a Hyspan company.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Install balancing valves in locations where they can easily be adjusted.
   B. Install Y-pattern strainers for water on supply side of each pump.
   C. Install water-hammer arresters in water piping according to PDI-WH 201.
   D. Install air vents at high points of water piping.

3.2 CONNECTIONS
   A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
   B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL
   A. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
   B. Prepare test and inspection reports.

3.4 ADJUSTING
   A. Set field-adjustable flow set points of balancing valves.

END OF SECTION
SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.

1.3 DEFINITIONS
   B. EPDM: Ethylene-propylene-diene terpolymer rubber.
   C. LLDPE: Linear, low-density polyethylene plastic.
   D. NBR: Acrylonitrile-butadiene rubber.
   E. PE: Polyethylene plastic.
   F. PVC: Polyvinyl chloride plastic.
   G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For solvent drainage system. Include plans, elevations, sections, and details.

1.6 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.7 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
1.8 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AB&I Foundry
      b. Charlotte Pipe and Foundry
      c. Tyler Pipe; Soil Pipe Division

B. Standard Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Dallas Specialty & Manufacturing Company
      c. Fernco Incorporated
      d. Ideal
      e. Matco-Norca, Incorporated
      f. MIFAB, Incorporated
      g. Mission Rubber Company; a division of MCP Industries, Incorporated
      h. Stant.
      i. Tyler Pipe.
   2. Standards: ASTM C 1277; CISPI Designation 310-09, NSF Certified.
   3. Description: 301 stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, Neoprene sleeve with integral, center pipe stop.
   4. Bands:
      a. NPS 4 inches and less: 2 bands, 60 inch pounds torque.
      b. NPS 5 to NPS 10: 4 bands, 60 inch pounds torque.
      c. NPS 12 and larger: 6 bands, 80 inch pounds torque.

C. Heavy-Duty, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Clamp-All Corp.
      c. Dallas Specialty & Manufacturing Company
      d. Ideal
e. MIFAB, Incorporated  
f. Mission Rubber Company; a division of MCP Industries, Incorporated  
g. Stant.  
h. Tyler Pipe.  


3. Description: 301 Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, Neoprene sleeve with integral, center pipe stop.  

4. Bands:  
a. NPS 4 inches and less: 4 bands, 80 inch pounds torque.  
b. NPS 5 to NPS 6: 6 bands, 80 inch pounds torque.  
c. NPS 8 and NPS 10: 6 bands, 80 inch pounds torque.  

D. Cast-Iron, Hubless-Piping Couplings:  
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
a. MG Piping Products Company.  
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, Neoprene sleeve with integral, center pipe stop.  

2.4 GALVANIZED-STEEL PIPE AND FITTINGS  
A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.  
C. Steel Pipe Pressure Fittings:  
D. Cast-Iron Flanges: ASME B16.1, Class 125.  
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.  
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.  
E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:  
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
a. Anvil International; a subsidiary of Mueller Water Products, Incorporated  
b. Grinnell Mechanical Products.  
c. Shurjoint Piping Products.  
d. Victaulic Company.  
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.
2.5 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:
   1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:
   1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

C. Ductile-Iron, Grooved-Joint Piping:
   2. Ductile-Iron-Pipe Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Anvil International.
         2) Shurjoint Piping Products.
         3) Victaulic Company.
      c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Non-pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Dallas Specialty & Manufacturing Company
         2) Fernco Incorporated
         3) Mission Rubber Company; a division of MCP Industries, Incorporated
         4) Plastic Oddities; a division of Diverse Corporate Technologies, Incorporated
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:
         2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

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4. Shielded, Non-pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
      1) Cascade Waterworks Manufacturing Company
      2) Mission Rubber Company; a division of MCP Industries, Incorporated
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
      1) Cascade Waterworks Manufacturing Company
      2) Dresser, Incorporated
      3) EBAA Iron, Incorporated
      4) JCM Industries, Incorporated
      5) Romac Industries, Incorporated
      6) Smith-Blair, Incorporated; a Sensus company.
      7) The Ford Meter Box Company, Incorporated
      8) Viking Johnson.
   c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   d. Center-Sleeve Material: Manufacturer's standard.
   e. Center-Sleeve Material: Manufacturer's standard.
   f. Gasket Material: Natural or synthetic rubber.
   g. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of
flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

M. Install steel piping according to applicable plumbing code.

3.2 PLUMBING SPECIALTIES
A. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties."
B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
C. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
D. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
E. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
F. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
G. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION
B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install fiberglass pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 18 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

J. Bracing: Horizontal cast-iron pipe and fittings NPS 5 and larger shall be braced to prevent horizontal movement. Bracing shall be located at each branch connection and each change of direction.
3.6 CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Install horizontal backwater valves with cleanout cover flush with floor.
   6. Comply with requirements for backwater valves, cleanouts, and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION
A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unsealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch w.g. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Soil and waste piping NPS 1.5 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; standard hubless-piping couplings; and coupled joints.

C. Soil and waste piping NPS 2 to NPS 10 shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; standard hubless-piping couplings; and coupled joints.

D. Vent piping NPS 1.5 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; standard hubless-piping couplings; and coupled joints.

END OF SECTION
SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Cleanouts.
      2. Floor drains.
      3. Roof flashing assemblies.
      4. Through-penetration fire stops assemblies.
      5. Miscellaneous sanitary drainage piping specialties.
      6. Flashing materials.
   B. Related Requirements:
      1. Division 22 Section "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.

1.3 DEFINITIONS
   B. FRP: Fiberglass-reinforced plastic.
   C. HDPE: High-density polyethylene plastic.
   D. PE: Polyethylene plastic.
   E. PP: Polypropylene plastic.
   F. PVC: Polyvinyl chloride plastic.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
   A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION
   A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
   B. Coordinate size and location of roof penetrations.
PART 2 PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
      g. Josam Company; Blucher-Josam Div.
   2. Standard: ASME A112.36.2M for cast iron or ASME A112.3.1 for stainless steel for cleanout test tee.
   3. Refer to cleanout schedule on drawings.

B. Metal Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Oatey.
      c. Sioux Chief Manufacturing Company, Inc.
      e. Tyler Pipe; Wade Div.
      f. Watts Drainage Products Inc.
      g. Zurn Plumbing Products Group; Light Commercial Operation.
      h. Zurn Plumbing Products Group; Specification Drainage Operation.
      i. Kusel Equipment Co.
   2. Standard: ASME A112.36.2M
   3. Refer to cleanout schedule on drawings.

C. Cast-Iron Wall Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M. Include wall access.
   4. Refer to cleanout schedule on drawings.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Commercial Enameling Co.
      b. Josam Company; Josam Div.
      c. MIFAB, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products Inc.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3 with backwater valve.
3. Refer to floor drain schedule on drawings:

B. Stainless-Steel Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Blucher-Josam Div.
   b. Josam Company; Josam Div.
   c. Kusel Equipment Co.
   d. Scherping Systems, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products Inc.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.3.1 or ASME A112.6.3.
3. Refer to floor drain schedule on drawings:

2.3 ROOF FLASHING ASSEMBLIES
A. Roof Flashing Assemblies <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company; Elmdor/Stoneman Div.
      b. Thaler Metal Industries Ltd.
B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES
A. Through-Penetration Firestop Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ProSet Systems Inc.
   2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   6. Special Coating: Corrosion resistant on interior of fittings.
2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
   1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
   2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch minimum water seal.

C. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:
   1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:
   1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
   2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals:
   1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper or galvanized steel.
   2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter-flashing.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz. /sq. ft.
   2. Vent Pipe Flashing: 8 oz. /sq. ft.
C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
E. Fasteners: Metal compatible with material and substrate being fastened.
F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
G. Solder: ASTM B 32, lead-free alloy.
H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.
B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
G. Install through-penetration fire stop assemblies in plastic conductors and stacks at floor penetrations.
H. Assemble open drain fittings and install with top of hub 2 inches above floor.
I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
K. Install vent caps on each vent pipe passing through roof.
L. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
N. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION
A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Install flashing for piping passing through roofs with counter-flashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL
A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 22 14 13
FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
      1. Storm Drainage Piping: 10-foot head of water. Coordinate with project requirements.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Required only for controlled-flow or siphonic roof drainage system. Include calculations, plans, and details.

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.6 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 PROJECT CONDITIONS
   A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
      1. Notify Owner no fewer than two days in advance of proposed interruption of storm-drainage service.
      2. Do not proceed with interruption of storm-drainage service without Owner's written permission.

PART 2 PRODUCTS

2.1 PIPING MATERIALS
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS
   A. Pipe and Fittings: ASTM A 888 or CISPI 301.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AB&I Foundry
   b. Charlotte Pipe and Foundry
   c. Tyler Pipe; Soil Pipe Division

B. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   c. Fernco Inc.
   d. Ideal
   e. Matco-Norca, Inc.
   f. MIFAB, Inc.
   g. Mission Rubber Company; a division of MCP Industries, Inc.
   h. Stant.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Clamp-All Corp.
   d. Ideal
   e. Matco-Norca, Inc.
   f. MIFAB, Inc.
   g. Mission Rubber Company; a division of MCP Industries, Inc.
   h. Stant.
   h. Tyler Pipe.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MG Piping Products Company.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in OD’s or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Non-pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2) Fernco Inc.
3) Mission Rubber Company; a division of MCP Industries, Inc.
4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. Sleeve Materials:
   2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2) Mission Rubber Company; a division of MCP Industries, Inc.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 EXECUTION

3.1 EARTH MOVING
A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of
lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes unless otherwise indicated by the local Authority Having Jurisdiction over the project:
   1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install steel piping according to applicable plumbing code.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION


B. Plastic, Non-pressure Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install fiberglass pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 1, adjustable, steel clevis hangers.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 18 inches of each fitting, valve, and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
   6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
C. Connect storm drainage piping to roof drains and storm drainage specialties.
   1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   2. Install horizontal backwater valves [with cleanout cover flush with floor] [in pit with pit cover flush with floor] <Insert description>.
   3. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."
D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION
A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.

D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
1. Roof drains.
2. Cleanouts.
3. Through-penetration firestop assemblies.
4. Flashing materials.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.1 METAL ROOF DRAINS
A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   c. Tyler Pipe.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Combination Flashing Ring and Gravel Stop: Not required
4. Extension Collars: Not required
5. Expansion Joint: Not required
6. Sump Receiver Plate: Not required
7. Vandal-Proof Dome: Not required
8. Refer to roof drain schedule for additional characteristics.

B. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   b. Marathon Roofing Products.
   c. Portals Plus; Commercial Products Group of Hart & Cooley, Inc.
   e. Tyler Pipe.
   f. Watts Water Technologies, Inc.
   g. Zurn Plumbing Products Group; Light Commercial Products Operation.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Combination Flashing Ring and Gravel Stop: Not required
4. Extension Collars: Not required
5. Expansion Joint: Not required
6. Sump Receiver Plate: Not required
7. Refer to roof drain schedule for additional characteristics.

2.2 CLEANOUTS

A. Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      b. Oatey.
      c. Sioux Chief Manufacturing Company, Inc.
      e. Tyler Pipe.
      f. Watts Water Technologies, Inc.
      g. Zurn Plumbing Products Group; Light Commercial Products Operation.
      h. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
   3. Size: Same as connected branch.
   4. Type: Adjustable housing
   5. Body or Ferrule Material: Cast iron
   6. Clamping Device: Not required
   7. Adjustable Housing Material: Cast iron or Plastic with threads or set-screws or other device.
   8. Frame and Cover Shape: Round
   10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      c. Tyler Pipe.
      d. Watts Water Technologies, Inc.
      e. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
   3. Size: Same as connected drainage piping.
   4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
   5. Closure Plug: Countersunk
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      b. MIFAB, Inc.
      d. Tyler Pipe.
      e. Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe tee as required to match connected piping.
5. Closure: Countersunk Raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES
A. Through-Penetration Firestop Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. ProSet Systems Inc.
   2. Standard: ASTM E 814, for through-penetration firestop assemblies.
   4. Size: Same as connected pipe.
   5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.4 FLASHING MATERIALS
A. Copper Sheet: ASTM B 152/B 152M, 12 oz. /sq. ft.
B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
D. Fasteners: Metal compatible with material and substrate being fastened.
E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
F. Solder: ASTM B 32, lead-free alloy.

PART 3 EXECUTION
3.1 INSTALLATION
A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
   1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Install expansion joints, if indicated, in roof drain outlets.
   3. Position roof drains for easy access and maintenance.
B. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate cleanouts at base of each vertical soil and waste stack.
D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
F. Install test tees in vertical conductors and near floor.
G. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
H. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
I. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS
A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION
A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION
A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Electric, storage, domestic-water heaters.
      2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings:
      1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
   A. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater, from manufacturer.
   B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
   C. Source quality-control reports.
   D. Field quality-control reports.
   E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
   C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.7 COORDINATION
   A. Coordinate sizes and locations of concrete bases with actual equipment provided.
1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.
   a. Electric, Domestic-Water Booster Heaters:
      i) Controls and Other Components: Five years.
   b. Compression Tanks: Five years.

PART 2 PRODUCTS

2.1 ELECTRIC, DOMESTIC-WATER HEATERS

A. Small-Capacity, (1 to 5 gallon capacity) Electric, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Bosch Water Heating.
   d. Electric Heater Company (The).
   e. GSW Water Heating.
   f. InSinkErator; a division of Emerson Electric Co.
   g. Lochinvar Corporation.
   h. Rheem Manufacturing Company.
   i. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   j. State Industries.
   k. Stiebel Eltron, Inc.
   l. WaiWela.


3. Storage-Tank Construction: Corrosion-resistant metal or steel with corrosion-resistant coating.
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:
   a. Drain Valve: ASSE 1005 if tank has drain outlet. Provide hose-end drain valve in piping for domestic-water heaters without drain outlet. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
   b. Insulation: Comply with ASHRAE 90.2.
   c. Jacket: Steel with enameled finish.
   d. Heating Element: One; electric, screw-in immersion type.
   e. Temperature Control: Adjustable thermostat.
   f. Safety Control: High-temperature-limit cutoff device or system.
   g. Power Supply Cord: 24 to 72 inches with plug.
   h. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
B. Electric, Storage, 6 to 120 gallon, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Electric Heater Company (The).
      d. GSW Water Heating.
      e. Heat Transfer Products, Inc.
      f. HESco Industries, Inc.
      g. Lochinvar Corporation.
      h. Rheem Manufacturing Company.
      i. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
      j. State Industries.
      k. Vaughn Manufacturing Corporation.
      b. Pressure Rating: 150 psig.
      c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   4. Factory-Installed Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium.
      b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
      c. Drain Valve: ASSE 1005.
      d. Insulation: Comply with ASHRAE 90.2.
      e. Jacket: Steel, cylindrical, with enameled finish.
      f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
      g. Heating Elements: Two; electric, screw-in immersion type; wired for non-simultaneous operation unless otherwise indicated. Limited to 12 kW total.
      h. Temperature Control: Adjustable thermostat.
      i. Safety Control: High-temperature-limit cutoff device or system.
      j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

C. Capacity and Characteristics:
   1. Refer to equipment schedules for capacity and characteristics.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL Inc.
      b. Flexcon Industries.
      c. Honeywell International Inc.
      d. Pentair Pump Group (The); Myers.
      e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
      f. State Industries.
      g. Taco, Inc.
   2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
3. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics:
   b. Capacity Acceptable: 10 gal. minimum.
   c. Air Pre-charge Pressure: 12 psig.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Combination Temperature-and-Pressure Relief Valves, if not part of water heater: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

F. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.


H. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and re-inspecting requirements and Section 017300 "Execution" for requirements for correcting the work.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Electric, Domestic-Water Heater Mounting: Install residential, electric, domestic-water heaters on floor.
   1. Maintain manufacturer's recommended clearances.
   2. Arrange units so controls and devices that require servicing are accessible.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Anchor domestic-water heaters to substrate.
B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
  1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
E. Install thermometers on outlet piping of electric, domestic water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
G. Fill electric, domestic-water heaters with water.
H. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS
A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping."

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION
A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL
A. Perform tests and inspections.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and re-inspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
C. Prepare test and inspection reports.
3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless electric, domestic-water heaters.

END OF SECTION
SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Interceptors.
   7. Shower receptors.
   8. Water closets.
   9. Urinals.
  10. Lavatories.
  11. Commercial sinks.
  13. Service sinks.

B. Related Sections include the following:
   1. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS


B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   5. Vitreous-China Fixtures: ASME A112.19.2M.
H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Faucets: ASME A112.18.1.
I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   2. Brass and Copper Supplies: ASME A112.18.1.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Floor Drains: ASME A112.6.3.
   2. Off-Floor Fixture Supports: ASME A112.6.1M.

1.6 WARRANTY
A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of unit shell.
      b. Faulty operation of controls, blowers, pumps, heaters, and timers.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period for Commercial Applications: Three years from date of Substantial Completion.
   3. Warranty Period Applications of Pumps and Blowers: Five years from date of Substantial Completion.
   4. Warranty Period for Applications of Electronic Controls: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 LAVATORY FAUCETS
A. Lavatory Faucets: Refer to plumbing fixture schedule
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Chicago Faucets.
      c. Elkay Manufacturing Company
      d. Grohe America, Incorporated
      e. Moen, Incorporated
      f. T & S Brass and Bronze Works, Incorporated

2.2 SINK FAUCETS
A. Sink Faucets: Refer to plumbing fixture schedule.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Incorporated
      b. Chicago Faucets.
      c. Elkay Manufacturing Company
      d. Grohe America, Incorporated
      e. Moen, Incorporated
      f. Speakman
      g. T & S Brass and Bronze Works, Incorporated
2.3 FLUSHOMETERS
   A. Flushometers: Refer to plumbing fixture schedule
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Sloan Valve Company.

2.4 TOILET SEATS
   A. Toilet Seats: Refer to plumbing fixture schedule
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. American Standard Companies, Incorporated
         b. Bemis Manufacturing Company.
         c. PlumBest
         d. Church Seats.
         e. Eljer.
         f. Kohler Company
         g. Olsonite Corp.
         h. Sanderson Plumbing Products, Incorporated; Beneke Division
         i. Sperzel.

2.5 PROTECTIVE SHIELDING GUARDS
   A. Protective Shielding Pipe Covers: Refer to plumbing fixture schedule.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Engineered Brass Company
         b. Insul-Tect Products Company; a Subsidiary of MVG Molded Products.
         c. McGuire Manufacturing Company, Incorporated
         d. Plumberex Specialty Products Incorporated
         e. TCI Products.
         f. TRUEBRO, Incorporated
      2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.6 FIXTURE SUPPORTS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Josam Company.
      2. Smith, Jay R. Mfg. Company
      3. Tyler Pipe; Wade Division
      4. Watts Drainage Products.
   B. Water-Closet Supports: Refer to plumbing fixture schedule
      1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
   C. Urinal Supports: Refer to plumbing fixture schedule.
      1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture and type II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.

D. Lavatory Supports: Refer to plumbing fixture schedule.
1. Description: Type I, lavatory carrier with exposed arms and tie rods, type II, lavatory carrier with concealed arms and tie rod, and type III, lavatory carrier with hanger plate and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

E. Sink Supports: Refer to plumbing fixture schedule.
1. Description: Type I, sink carrier with exposed arms and tie rods, type II, sink carrier with hanger plate, bearing studs, and tie rod, and type III, sink carrier with hanger plate and exposed arms for sink-type fixture. Include steel uprights with feet.

2.7 WATER CLOSETS
A. Water Closets: Refer to plumbing fixture schedule
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Incorporated
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Eljer.
   d. Kohler Company
   e. Sloan Valve Company

2.8 URINALS
A. Urinals: Refer to plumbing fixture schedule.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Incorporated
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Eljer.
   d. Kohler Company
   e. Sloan Valve Company

2.9 LAVATORIES
A. Lavatories; Refer to plumbing fixture schedule.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Incorporated
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Eljer.
   d. Kohler Company
   e. Sloan Valve Company

2.10 COMMERCIAL SINKS
A. Commercial Sinks: Refer to plumbing fixture schedule.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Tabco.
   b. Elkay Manufacturing Company
   c. Just Manufacturing Company.
   d. Metal Masters Foodservice Equipment Company, Incorporated
2.11 KITCHEN SINKS
   A. Kitchen Sinks: Refer to plumbing fixture schedule.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Elkay Manufacturing Company
         b. Franke Consumer Products, Incorporated, Kitchen Systems Division
         c. Just Manufacturing Company.
         d. Kohler Company
         e. Moen, Incorporated
         f. Revere Sink.
         g. Sterling Plumbing Group, Incorporated

2.12 SERVICE SINKS
   A. Service Sinks: Refer to plumbing fixture schedule.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. American Standard Companies, Incorporated
         b. Commercial Enameling Company.
         c. Eljer.
         d. Kohler Company

2.13 SERVICE BASINS
   A. Service Basins: Refer to plumbing fixture schedule.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         b. Crane Plumbing, L.L.C./Fiat Products.
         c. Florestone Products Company, Incorporated
         d. Precast Terrazzo Enterprises, Incorporated
         e. Stern-Williams Company, Incorporated

PART 3 EXECUTION

3.1 COORDINATION
   A. Coordinate plumbing fixture rough-in locations and plumbing fixture manufactures installation requirements.

3.2 EXAMINATION
   A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
   B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed before rough-in.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION
   A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers’ written instructions.
   B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
      1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
      2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
      3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install counter-mounting fixtures in and attached to casework.

F. Install fixtures level and plumb according to roughing-in drawings.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

J. Install accessible urinals with rim height not more than 17-inches or less than 16.5-inches above the finished floor.

K. Install flush valves for accessible urinals with handle centered 44-inches above the finished floor.

L. Install toilet seats on water closets.

M. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

N. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

O. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, moldew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.
3.6 ADJUSTING
A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
C. Replace washers and seals of leaking and dripping faucets and stops.
D. Install fresh batteries in sensor-operated mechanisms.

3.7 CLEANING
A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.
B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.8 PROTECTION
A. Provide protective covering for installed fixtures and fittings.
B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 22 47 13
DRINKING FOUNTAINS AND WATER COOLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following water coolers and related components:
      1. Pressure water coolers.
      2. Fixture supports.

1.3 DEFINITIONS
   A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
   B. Cast Polymer: Dense, cast-filled-polymer plastic.
   C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
   D. Fitting: Device that controls flow of water into or out of fixture.
   E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
   F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
   G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS
   A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
   B. Shop Drawings: Diagram power, signal, and control wiring.
   C. Field quality-control test reports.
   D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Elkay Manufacturing Company
   2. Halsey Taylor.
   4. Oasis Corporation.
   5. Sunroc Corporation

B. Description: Refer to drawings.

2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Company
   2. Smith, Jay R. Mfg. Company
   3. Tyler Pipe; Wade Division
   4. Watts Drainage Products Incorporated; a div. of Watts Industries, Incorporated
   5. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
   1. Type I: Hanger-type carrier with two vertical uprights.
   2. Type II: Bilevel, hanger-type carrier with three vertical uprights.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use a ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section “General-Duty Valves For Plumbing Piping”.

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section “Common Work Results For Plumbing”.

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section “Joint Sealants.”

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section “Grounding and Bonding.”

D. Connect wiring according to Division 26 Section “Conductors and Cables.”

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
   1. Remove and replace malfunctioning units and retest as specified above.
   2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer’s written instructions.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   5. HVAC demolition.
   6. Equipment installation requirements common to equipment sections.
   7. Painting and finishing.
   8. Concrete bases.

1.3 BASIS-OF-DESIGN
A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufactures listed in the specification other than the basis-of design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.4 DEFINITIONS
A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.
G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.
1.5 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Escutcheons.

B. Welding certificates.

C. Coordination Drawings: Submit one copy for the engineers use. Division 23 coordination drawings will not be returned.
   1. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
      a. Planned piping layout, including valve and specialty locations and valve-stem movement.
      b. Planned piping hanger layout including building attachments and building structural coordination.
      c. Clearances for installing and maintaining insulation.
      d. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
      e. Equipment and accessory service connections and support details
      f. Exterior wall and foundation penetrations.
      g. Fire- and smoke-rated wall and floor penetration.
      h. Sizes and locations of required concrete equipment curbs and bases.
      i. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
      j. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
      k. Access door and panel locations.
      l. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

D. Equipment startup reports.
   1. Reports will indicate equipment was started and tested according to the manufactures recommendations and is operating as specified. Included test data.

1.6 QUALITY ASSURANCE

A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
1.7 GUIDELINES, CODES AND STANDARDS
   A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.
   B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
   B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
   C. Deliver ducts and air handling equipment with factory or shop applied protective covering. Protective covering shall remain until installation.
   D. Materials and equipment stored on site shall have a protective covering; open ends on equipment connections and ducts shall be covered. Duct liner shall be encapsulated.

1.9 COORDINATION
   A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
   B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
   C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.1 MANUFACTURERS
   A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
      1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS
   A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
   B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS
   A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
   B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
      1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
         a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
         b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
      2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Pipeline Seal and Insulator, Incorporated (Pipeline Seal and Insulator, Incorporated)
   3. Watts Industries, Incorporated; Water Products Division (www.watts.com)
B. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
D. Dielectric-Flange Kits: Companion-flange assembly for field-assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 degrees F.

2.5 CONCRETE BASES
A. Refer to Division 03 Section "Cast-in-Place Concrete".

2.6 GROUT
A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION
3.1 HVAC DEMOLITION
A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS
A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Sleeves are not required for core-drilled holes through walls.
M. Verify final equipment locations for roughing-in.
N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION
A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B 813, water-pushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in steel piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Wet Piping Systems: Install dielectric nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install HVAC equipment according to the equipment manufacturer’s installation instructions and as indicated on the drawings. Resolve conflicting instructions, with the architect before mounting equipment.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. Refer to equipment shop drawings for rough in locations; do not scale drawings.

3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer’s written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section “Cast-in-Place Concrete”.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES
   A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
   B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
   C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES
   A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
   B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
   C. Attach to substrates as required to support applied loads.

3.10 GROUTING
   A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
   B. Clean surfaces that will come into contact with grout.
   C. Provide forms as required for placement of grout.
   D. Avoid air entrapment during placement of grout.
   E. Place grout, completely filling equipment bases.
   F. Place grout on concrete bases and provide smooth bearing surface for equipment.
   G. Place grout around anchors.
   H. Cure placed grout.

3.11 SEALANTS
   A. Comply with joint-sealant materials and applications specified in Section 078400 “Firestopping,” Section 078443 “Fire-resistant Joint Sealants,” Section 079000 “Joint Protection,” and Section 092900 “Gypsum Board: Acoustical sealants.”

3.12 RESPONSIBILITY MATRIX (RECOMMENDED)
   A. The responsibility matrix is a partial list of items requiring coordination and is only a recommendation to the contractor. The contractor is responsible for the complete installation and operation of equipment and materials.
   B. Refer to Division 22 Section “Common Work results for Plumbing” for additional requirements.
C. Key:
1. BAS: Building Automation System (Temperature Control Installer)
2. FP: Fire Protection (Division-21)
3. PLBG: Plumbing Installer (Division-22)
4. HVAC: Mechanical Installer (Division-23)
5. E = Electrical Installer (Division-26)
6. D = Data/Communication Cabling Installer (Division-27)
7. O = Other

<table>
<thead>
<tr>
<th>System Description</th>
<th>Furnished By</th>
<th>Installed By</th>
<th>Wired/Piped By</th>
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<td>24v power to dampers/valves</td>
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<td>24v power to VAV air terminal</td>
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END OF SECTION
SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes general requirements for single-phase and polyphase, general-purpose,
   horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to
   600 V and installed at equipment manufacturer’s factory or shipped separately by equipment
   manufacturer for field installation.

1.3 COORDINATION
A. Coordinate features of motors, variable frequency controllers, installed units, and accessory
   devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.
   5. Variable frequency controllers.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when stricter requirements are specified in HVAC
   equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea
   level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads
   at designated speeds, at installed altitude and environment, with indicated operating sequence,
   and without exceeding nameplate ratings or considering service factor.

2.3 SINGLE-PHASE MOTORS
A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of
   specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Permanent-split-capacitor type.
C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust
   loading.
D. Motors 1/20 HP and Smaller: Shaded-pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Variable Frequency Motor Controller Bypass

C. VFC Filtering

D. Related Requirements:
   1. Section 260500 "Common Work Results for Electrical" for basic installation requirements.
   2. Section 260526 "Grounding and Bonding for Electrical Systems" for basic materials and installation of grounding.
   3. Section 262200 "Low-Voltage Transformers" for transformers to serve VFC's.
   4. Section 262813 "Fuses" for installation in VFC's and bypass units.
   5. Section 262816 "Enclosed Switches and Circuit Breakers" for disconnects and overcurrent protection of VFC's.

1.2 DEFINITIONS
A. CE: Conformite Europeene (European Compliance).
B. CPT: Control power transformer.
C. DDC: Direct digital control.
D. EMI: Electromagnetic interference.
E. LED: Light-emitting diode.
F. NC: Normally closed.
G. NO: Normally open.
H. OCPD: Overcurrent protective device.
I. PID: Control action, proportional plus integral plus derivative.
J. PWM: Pulse Width Modulation
K. RFI: Radio-frequency interference.
L. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS
A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.

7. Include mounting and attachment details.

8. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

9. Include diagrams for power, signal, and control wiring.

10. Detailed installation drawings including:
   a. Control terminals, designation, and locations
   b. Power circuit diagram identifying disconnects, bypass disconnect, filters or isolation transformer, and motor.
   c. Internal electrical wiring and control circuit diagram
   d. Wiring of auxiliary devices and optional inputs.
   e. Interconnection to harmonic filter traps, line reactors, and dV/dT filters.

11. Furnish a technical brochure or matrix detailing standard VFC features.
   a. Motor horsepower and amperage rating.
   b. Power factor at full load.
   c. Input power characteristics.
   d. Full load Efficiency.
   e. Control interface requirements.
   f. Status display system.
   g. Options not listed in specifications.

12. Exceptions and variations from the specification.

13. Include steady state and fault current ratings.

14. Filter characteristics:
   a. Dimensional drawings with installed weight for each size.
   b. Power input characteristics.
   c. Wiring diagram

C. Contractor shall obtain all the VFC’s from a single manufacturer for the entire Project. Coordinate between Division 23 prior to submitting shop drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Required working clearances and required area above and around VFCs.
   2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
   3. Show support locations, type of support, and weight on each support.
   4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Product Certificates: For each VFC from manufacturer.


E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
      b. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
      c. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE
A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
   B. Provide Variable Frequency Controllers suitable for operating with NEMA Design B induction motors. VFC's shall be compatible with standard 3 phase high efficiency motors.
   C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING
A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. VFC Warranty Period: Five years from date of Substantial Completion.
   2. Filter Warranty Period: Three years from date of Substantial Completion.
PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Variable Frequency Motor Controller Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. ABB Low-Voltage HVAC Drives
   2. Danfoss Inc; Danfoss Drives Div.

C. Harmonic Trap Filters, dV/dT, Filters, and Input Line Reactor Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trans Coil Inc.
   2. MTE
   3. Myron Zucker
   4. Schaffner

2.2 VFC SYSTEM DESCRIPTION AND RATINGS

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: Constant torque or variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, “Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both.”
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, “Definite-Purpose Inverter-Fed Polyphase Motors.”
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 66 Hz, with torque constant as speed changes; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 100 percent speed and greater than 80 percent at 50 percent speed.
   5. Minimum Power Factor: 95 percent at 100 percent speed and greater than 90 percent at 25 percent speed.
6. Bus capacitance voltage ratings
   a. 208-240V VFC’s shall have a minimum bus voltage capacitance of 400 VDC.
   b. 460-480V VFC’s shall have a minimum bus voltage capacitance of 800 VDC.
7. IGBT ratings
   a. 208-240V VFC’s shall be equipped with IGBT’s that have a minimum \( V_{ce} \) rating of 600V.
   b. 460-480V VFC’s shall be equipped with IGBT’s that have a minimum \( V_{ce} \) rating of 1200V.
8. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
9. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
11. Altitude Rating: Not exceeding 3300 feet (1000 m).
12. Audible noise shall not exceed 85 dBA measured at a point 3 feet from the VFC.
14. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
15. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
16. Speed Regulation: Plus or minus 10 percent.
17. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
18. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Converter Section
   1. Utilize six-pulse full wave diode or PWM bridge design to convert fixed voltage and frequency AC line power to fixed DC voltage.
   2. Operation of the converter section shall be unaffected by phase rotation.
   3. Input shall have MOVs (Metal Oxide Varistors) for surge protection.

H. DC Bus Section
   1. DC bus shall include a minimum 5% integrated DC link reactors to minimize harmonic distortion.
   2. DC bus shall have a passive capacitive filter to minimize ripple and maximize power-loss ride through.
   3. Provide balance discharge resistors to equalize charge voltage and permit safe discharge of capacitors upon loss of power.

I. Inverter Section
   1. Utilize isolated-gate bipolar transistors (IGBTs) to convert DC bus voltage to tree phase, variable frequency, and sinusoidal coded PWM waveform to control the motor. Six step and current source drives are not acceptable.
   2. PWM switching frequencies (Carrier Frequency): Selectable; 1.0 to 12 kHz. Factor set the carrier frequency at 3 kHz.
   3. VFC shall be capable of skipping over minimum of two critical frequencies to prevent the VFC from operating the load continuously at unstable speeds. VFC shall accelerate or decelerate through these ranges, but not be allowed to operate consistently in these ranges.

J. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

K. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

L. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.
M. Self-Protection and Reliability Features:
   1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
   3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   5. Inverter overcurrent trips.
   6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC over- temperature and motor-overload alarm and trip; settings selectable via the keypad.
   7. Critical frequency rejection, with three selectable, adjustable deadbands.
   8. Instantaneous line-to-line and line-to-ground overcurrent trips.
  11. Short-circuit protection.

N. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

O. Power- Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

P. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

Q. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

R. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

2.3 PERFORMANCE REQUIREMENTS

A. If audible motor noise created by the VFC exceeds 5 dB of the motor noise generated when the motor is directly connected to line power through an across the line starter, the VFC supplier shall remedy the situation at no cost.

2.4 CONTROLS AND INDICATION

A. Electrically isolate the following circuit systems from the main power circuits:
   1. Internal control circuiting regulating DC bus voltage and inverter output frequency.
   2. Circuitry supplying various microprocessors, controllers, sensors, etc., which provide the VFC’s operational and safety features.

B. Provide devices which will limit the following operational parameters:
   1. Permit field adjustment of minimum and maximum output frequency. The range shall be adjustable from 4 Hz to 60 Hz.
   2. Permit field adjustment of the acceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range acceleration rates initially at 60 seconds.
   3. Permit field adjustment of the deceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range deceleration rate at 60 seconds.
C. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.

D. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

E. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

F. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).
   11. Heat sink temperature
   12. Operating hours (with reset function)
   13. Megawatt hours (with reset function)

G. VFC Monitoring and Alarming
   1. The VFC controller shall have the ability to display the following alarms and notifications at the VFC display as well as the relay the to the building automation system via communications interface.
      a. Status indicators
         1) On/Off status
         2) Input power Status
         3) Input power fault
         4) Over-current fault
         5) Ground fault
         6) Under-voltage
         7) Over-voltage
         8) Over-temperature fault
         9) Motor over-load fault
        10) Motor under-load fault
11) DC braking
12) Emergency off
13) Retry
14) Restart

b. Alarms
1) Over-voltage pre-alarm
2) Over-current pre-alarm
3) Under-voltage
4) Overheat pre-alarm
5) Overload pre-alarm
6) Communications Error
7) Tuning Error
8) Point setting alarm
9) Clear enabling indication
10) Emergency Stop Enabling indication
11) Setting Error Alarm
12) Momentary power loss slowdown
13) Lower-limit time-out stop
14) VFD in bypass

c. Faults
1) Over-current (start up)
2) Over-current (Acceleration, Deceleration, and Running)
3) U-phase short
4) V-phase short
5) W-phase short
6) Over-voltage (Acceleration, Deceleration, and Running)
7) Under-voltage
8) Over-frequency
9) Under-frequency
10) Over-heat
11) Over-heat (external)
12) Over-torque
13) Inverter overload
14) Motor overload
15) Ground Fault
16) Input phase failure
17) Output phase failure
18) Sequence error
19) Speed error
20) V/Hz control error
21) Communications error
22) Logic voltage error
23) Self-diagnostics alarm
24) VFD in bypass

d. VFC shall be equipped of automatic reset and restart circuit which will restart the motor 20 seconds after self-protection shut down. The VFC shall attempt no more than 5 automatic restarts. Each successive attempt shall occur at least 120 seconds after the last.

H. Control Signal Interfaces (I/O):
1. Electric Input Signal Interface:
   a. A minimum of [two] <Insert number> programmable analog inputs: 0- to 10-V dc [4- to 20-mA dc] [Operator-selectable "x"- to "y"-mA dc] <Insert signal parameters>.
   b. A minimum of [six] <Insert number> multifunction programmable digital inputs.
2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
4. VFC shall be equipped with a 120 VAC or 24 VDC safety circuit for fire alarm system shutdown.
5. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20 mA dc), which can be configured for any of the following:
   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).
   g. <Insert indication>.
6. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120- V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

I. Communications Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC’s nonvolatile memory.
   1. Hardwired Points:
      b. Control: On-off operation.
   2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.
      a. Coordinate with Division 23 and provide signal compatibility for a direct serial communications interface with:
         1) Verify existing control system in existing building.

2.5 LINE CONDITIONING AND FILTERING
   A. Provide UL listed Filters for the application.
   B. Filters shall be located adjacent to the VFC or contained in a common enclosure as the VFC it is serving.
   C. Filter enclosures shall be meet the same requirements as specified for VFC’s.
   D. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.
   E. Input Line Conditioning
      1. Provide a 5% input line reactor on the input of all VFC’s greater than 50 HP in addition to any internal line reactors and filters.
      2. Provide harmonic filters on the input of all VFC’s serving motors greater than 50 HP
         a. Provide contactor within filter to disconnect capacitors from line power to the VFC when signal is received from the VFC. VFC shall be programed to disconnect capacitors at 25% load and energize capacitors at 30% load.
b. Provide contactor to bypass entire filter when VFD has been bypassed. Provide interlock between bypass switch and contactor.
3. VFC disconnecting means shall disconnect power to input filter and reactors.

F. Output Filtering: Provide dV/dt filters for all locations where conductors between the motors and VFC are 75 feet or longer.

G. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
1. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) for motors less than 40 HP, Reduced-voltage (autotransformer) for motors 40 HP and larger type.
1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 50 VA.
   a. Solid-State Overload Relays:
      1) Switch or dial selectable for motor-running overload protection.
      2) Sensors in each phase.
      3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      5) Analog communication module.
   b. NC isolated overload alarm contact.
   c. External overload, reset push button.
2.7 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 3R.
   4. Other Wet or Damp Indoor Locations: Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

C. Internal cooling fans and filers shall be provided where required to maintain drive operating temperature.

D. Internal heating elements shall be provided where required to maintain drive operating temperature.

E. Provide lifting provisions for units weighing more than 80 pounds.

F. All units shall be provided with a grounding lug.

G. The enclosure shall have a through-the-door interlocking handle with padlocking provisions.

H. Wall units shall be provided with necessary mounting brackets.

2.8 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.


E. Supplemental Digital Meters:
   1. Elapsed-time meter.
   2. Kilowatt meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. The VFC manufacturer shall obtain information about any critical speeds, which must be locked out in the VFC controls to avoid noise and vibration caused by harmonic resonance in the mechanical system.

B. Contractor shall coordinate final VFC locations with VFC manufacturer and mechanical equipment layouts.

3.3 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 66 inches (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Separate line, load, and control conductors in separate continuous metallic conduits. Provide ferrous metallic shielding around each VFC conductor group when conductors are installed in wire way or gutter. The contractor may submit shielded conductor cable assemblies designed for operation with VFC’s.

E. Provide all power connection including wiring associated with any isolation transformer disconnect reactors, filters, and any accessories. Include power wiring from the VFC to the motor, as well as all grounding connections.

F. Where it is not possible to install motors within the sight of the VFC provide a disconnect switch at the motor as required by the NEC or required by the specifications. Provide an interlocking connection between the disconnect at the motor and the VFC to prevent the VFC from operating in a no load situation.

G. All connections to the VFC shall be with a minimum 18 inches of seal tight flexible conduit, allowing for ease of maintenance.

H. Provide separate grounding conductor to the VFC and between the VFC and the motor in addition to the conduit system.

I. Temperature control contractor shall provide all control connections to the VFC from any sensors or control devices.

J. Provide separate overload protection for each motor when a VFC serve multiple motors.

K. Install fuses in each fusible-switch VFC.

L. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

M. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

N. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

O. Comply with NECA 1.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.5 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.
3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
   5. Test each motor for proper phase rotation.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
   10. Test voltage distortion. Voltage distortion shall not exceed 3% and the line notch depth shall not exceed 10% as defined in IEEE Standard 519-1992 “IEEE Guide for Harmonic control and Reactive Compensation of Static Power Converters.” Provide necessary harmonic filters or line reactors to achieve these values. A written report shall be provided to the engineer showing all test results.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. At a minimum perform the following operational checks and provide a report to the engineer that each VFC has met the following checks:
      a. Maximum output frequency = 60 Hz ± 1 Hz.
      b. Minimum output frequency = 4 Hz ± 1 Hz.
      c. Control signal setpoint ± 10% of that specified.
      d. Simulated power outage and control system reaction.
      e. Manual bypass switchover and operation tested.
f. Starting into an already rotating motor load and determine if self-protection of the VFC is adequate.
g. Acceleration rate from a dead stop to full speed at the maximum and minimum rate adjustment.
h. Deceleration rate from full speed to dead stop at maximum and minimum rate adjustment.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 “Overcurrent Protective Device Coordination Study.”

F. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs. The manufacturer shall arrange for and conduct a user training session(s) at the Project site, explaining the operation of each type of VFC package. Allow for a minimum 4 hours of training for the first VFC and 1 hours of training for each additional VFC up to a maximum of 15 hours. The supplier shall notify the Engineer of the training session at least 1 week prior to the scheduled date so the Engineer can make arrangement to attend.

END OF SECTION
SECTION 23 05 17
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Incorporated (www.apsonline.com)
   2. CALPICO, Incorporated (www.calpicoinc.com)
   4. Pipeline Seal and Insulator, Incorporated (www.pipelineseal.com)
   5. Proco Products, Incorporated (www.procoproducts.com)
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe.
      Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.
PART 3 EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

F. Acoustical Interior Wall Penetrations: Maintain indicated STC rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with acoustical sealant materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller than NPS 6 Sleeve-seal fittings.
2. **Exterior Concrete Walls below Grade:**
   a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      i) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
      i) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. **Concrete Slabs-on-Grade:**
   a. Piping Smaller Than NPS 6: Galvanized-steel sleeves with sleeve-seal system.
      i) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
      i) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. **Concrete Slabs above Grade:**
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. **Interior Partitions:**
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves

END OF SECTION
SECTION 23 05 18
ESCUTCHEONS FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Escutcheons.
      2. Floor plates.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
   D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
   E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.
   B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
      1. Escutcheons for New Piping:
         a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
         b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
         c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

2. Escutcheons for Existing Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION
SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Light-activated thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.
B. Related Sections:
   1. Division 23 Section "Facility Natural-Gas Piping" for gas meters.
   2. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Product Certificates: For each type of meter and gage, from manufacturer.
C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 LIGHT-ACTIVATED THERMOMETERS
A. Direct-Mounted, Light-Activated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flo Fab Incorporated
      b. REOTEMP Instrument Corporation.
      c. Trerice, H. O. Company
      d. Weiss Instruments, Incorporated
      e. WIKA Instrument Corporation - USA.
      f. Winters Instruments - U.S.
   2. Case: Plastic; 7-inch nominal size unless otherwise indicated.
   3. Scale(s): Degrees F and degrees C.
   6. Stem: Aluminum and of length to suit installation.
      b. Design for Thermowell Installation: Bare stem.
   8. Accuracy: Plus or minus 1 degrees F.
2.2 DUCT-THERMOMETER MOUNTING BRACKETS
   A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS
   A. Thermowells:
      2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
      3. Material for Use with Copper Tubing: CNR or CUNI.
      4. Material for Use with Steel Piping: CRES or CSA.
      5. Type: Stepped shank unless straight or tapered shank is indicated.
      6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
      7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
      8. Bore: Diameter required to match thermometer bulb or stem.
      9. Insertion Length: Length required to match thermometer bulb or stem.
     10. Lagging Extension: Include on thermowells for insulated piping and tubing.
     11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
   B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES
   A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. AMETEK, Incorporated; U.S. Gauge.
         b. Ashcroft Incorporated.
         c. Ernst Flow Industries.
         d. Flo Fab Incorporated.
         e. Marsh Bellofram.
         f. Miljoco Corporation.
         g. Noshok.
         h. Palmer Wahl Instrumentation Group.
         i. REOTEMP Instrument Corporation.
         j. Tel-Tru Manufacturing Company.
         k. Trerice, H. O. Company.
         l. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated.
         m. Weiss Instruments, Incorporated.
         n. WIKA Instrument Corporation - USA.
         o. Winters Instruments - U.S.
      3. Case: Sealed type; cast aluminum; 4-1/2-inch nominal diameter.
      4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
      5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
      6. Movement: Mechanical, with link to pressure element and connection to pointer.
      7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
      11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
2.5 GAGE ATTACHMENTS
A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.
C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design, Incorporated
   3. National Meter, Incorporated
   4. Peterson Equipment Company, Incorporated
   5. Sisco Manufacturing Company, Incorporated
   6. Trerice, H. O. Company
   7. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated
   8. Weiss Instruments, Incorporated
B. Description: Test-station fitting made for insertion into piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
E. Minimum Pressure and Temperature Rating: 500 psig at 275 degrees F.
F. Core Inserts: EPDM self-sealing rubber.

2.7 TEST-PLUG KITS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design, Incorporated
   3. National Meter, Incorporated
   4. Peterson Equipment Company, Incorporated
   5. Sisco Manufacturing Company, Incorporated
   6. Trerice, H. O. Company
   7. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated
   8. Weiss Instruments, Incorporated
B. Furnish two test-plug kits containing one thermometers, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 degrees Fs 104 degrees C.
D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
E. Carrying Case: Metal or plastic, with formed instrument padding.
PART 3 EXECUTION

3.1 INSTALLATION
A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
H. Install valve and syphon fitting in piping for each pressure gage for steam.
I. Install test plugs in piping tees.
J. Install connection fittings in accessible locations for attachment to portable indicators.
K. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic boiler.
   2. Two inlets and two outlets of each chiller.
   3. Inlet and outlet of each hydronic coil in air-handling units.
   4. Two inlets and two outlets of each hydronic heat exchanger.
   5. Inlet and outlet of each thermal-storage tank.
L. Install pressure gages in the following locations:
   1. Discharge of each pressure-reducing valve.
   2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
   3. Suction and discharge of each pump. Refer to piping detail.

3.2 CONNECTIONS
A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING
A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
A. Thermometers at inlet and outlet of each hydronic zone shall be the following:
   1. Test plug with EPDM self-sealing rubber inserts.
B. Thermometers at inlet and outlet of each hydronic boiler shall be the following:
   1. Direct-mounted, light-activated type.
   2. Test plug with EPDM self-sealing rubber inserts.
C. Thermometers at inlets and outlets of each chiller shall be the following:
   1. Direct-mounted, light-activated type.
   2. Test plug with EPDM self-sealing rubber inserts.
D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:
   1. Direct-mounted, light-activated type.
   2. Test plug with EPDM self-sealing rubber inserts. Air-handling units with multiple coils will have test plugs for each coil.

E. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
   1. Direct-mounted, light-activated type.
   2. Test plug with EPDM self-sealing rubber inserts.

F. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: Minus 40 to plus 160 degrees F and minus 40 to plus 100 degrees C.

B. Scale Range for Condenser-Water Piping: zero to 100 degrees F and minus 20 to plus 50 degrees C.

C. Scale Range for Heating, Hot-Water Piping: 0 to 250 degrees F and 0 to 150 degrees C.

D. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 degrees F and 0 to 150 degrees C.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
   1. Sealed, direct-mounted, metal case.

B. Pressure gages at suction and discharge of each pump shall be the following:
   1. Sealed, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi.

B. Scale Range for Condenser-Water Piping: 0 to 100 psi.

C. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Bronze ball valves.
      2. Iron, single-flange butterfly valves.
      5. Bronze lift-check valves.
      8. Iron gate valves.
   B. Related Sections:
      1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
      2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS
   A. CWP: Cold working pressure.
   B. EPDM: Ethylene propylene copolymer rubber.
   C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
   D. NRS: Non-rising stem.
   E. OS&Y: Outside screw and yoke.
   F. RS: Rising stem.
   G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   B. ASME Compliance:
      1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
      2. ASME B31.1 for power piping valves.
      3. ASME B31.9 for building services piping valves.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor
      storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use
   handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system
   pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Hand lever: For quarter-turn valves NPS 6 and smaller.
   4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug
      valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective
      sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim; MSS-SP110:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Incorporated; Apollo Valves. (Example: 70-140-xx)
         (www.apollovalves.com)
      b. Crane Company; Crane Valve Group; Crane Valves (www.cranecvalve.com) (Example 9201-S)
      d. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example: 20BSOR-02)
      e. NIBCO Incorporated (www.nibco.com) (Example: T585-66)
2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

B. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim; MSS-SP110:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Incorporated; Apollo Valves. (Example 100-70-XX) (www.apollovalves.com)
      b. Crane Co.; Crane Valve Group; (Example 9210) (www.cranevalve.com)
      c. Hammond Valve. (www.hammondvalve.com) (Example 8501)
      d. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example BA-100)
      e. NIBCO Incorporated (www.nibco.com) (Example T580-70)

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Regular.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Incorporated; Apollo Valves. (Example 143 Series) (www.apollovalves.com)
      b. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com). (Example LD 712)
      c. Legend Valve. (www.legendvalve.com) (Example T365AB)
      d. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example CL223-E)
      e. NIBCO Incorporated (www.nibco.com) (Example LD2000-3)
      f. Spence Strainers International; a division of CIRCOR International. (Example BF Series)
      g. Watts Regulator Co.; a division of Watts Water Technologies, (Example BF-03) (www.watts.com)

2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.
2.4 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mueller Steam Specialty; a division of SPX Corporation. (www.muellersteam.com) (Example: 89-GEN)
      b. NIBCO Incorporated. (www.nibco.com) (Example: GD4765-5)
      c. Victaulic Company. (www.victaulic.com) (Example: Series 761)
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 175 psig.
      c. Body Material: Coated, ductile iron.
      e. Disc: Coated, ductile iron.
      f. Seal: EPDM.

B. 300 CWP, Iron, Grooved-End Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. NIBCO Incorporated (www.nibco.com) (Example: #4775)
      c. Victaulic Company. (www.victaulic.com)
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. NPS 8 and Smaller CWP Rating: 300 psig.
      c. NPS 10 and Larger CWP Rating: 200 psig.
      d. Body Material: Coated, ductile iron.
      e. Stem: Two-piece stainless steel.
      f. Disc: Coated, ductile iron.
      g. Seal: EPDM.

2.5 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABZ Valve and Controls; a division of ABZ Manufacturing, (Example: Series 400) (www.abzvalve.com)
      b. DeZurik Water Controls. (Example: BHP) (www.dezurik.com)
      c. Hammond Valve. (www.hammondvalve.com) (Example: HP1LCS)
      d. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example: HP1LCS)
      e. NIBCO Incorporated (www.nibco.com) (Example: LCS6822)
      f. Process Development & Control, (Example: Series 60)
      g. Tyco Valves & Controls; a unit of Tyco Flow Control. (Example: Venessa QTF 30000) (www.tycoflowcontrol.com/valves)
      h. Xomox Corporation. (Example: Series 821)
   2. Description:
      a. Standard: MSS SP-68.
      b. CWP Rating: 285 psig at 100 deg F.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
      e. Seat: Reinforced PTFE or metal.
      f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
  h. Service: Bidirectional.

B. Class 300, Single-Flange, High-Performance Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABZ Valve and Controls; a division of ABZ Manufacturing, Incorporated. (www.abzvalve.com)
      b. DeZurik Water Controls. (Example: BHP) (www.dezurik.com)
      c. Hammond Valve. (www.hammondvalve.com) (Example: HP3LCS)
      d. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example: HP3LCS)
      e. NIBCO Incorporated (www.nibco.com) (Example: LC76822)
      f. Process Development & Control, (Example: Series 60)
      g. Tyco Valves & Controls; a unit of Tyco Flow Control. (Example: Venessa QTF 30000) (www.tycoflowcontrol.com/valves)
      h. Xomox Corporation. (Example: Series 823)
   i.

2. Description:
   a. Standard: MSS SP-68.
   b. CWP Rating: 720 psig at 100 deg F.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, cast iron, or ductile iron.
   e. Seat: Reinforced PTFE or metal.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Carbon steel.
   h. Service: Bidirectional.

2.6 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Crane Valves (www.cranevalve.com)
      b. Crane Company; Crane Valve Group; Jenkins Valves (www.jlvalve.com)
      c. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com).
      d. Hammond Valve. (www.hammondvalve.com)
      e. Kitz Corporation. (www.kitz.com)
      f. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example 509T)
      g. NIBCO Incorporated (www.nibco.com) (Example T-413-BY)
      h. Red-White Valve Corporation. (www.redwhitevalvecorp.com)
      i. Watts Regulator Co.; a division of Watts Water Technologies, Incorporated. (www.watts.com)
   2. Description:
      a. Standard: MSS SP-80, Type 4.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: PTFE or TFE.

B. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Crane Valves (www.cranevalve.com)
      b. Crane Company; Crane Valve Group; Jenkins Valves (www.jlvalve.com)
      c. Hammond Valve. (www.hammondvalve.com)
2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.

2.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Crane Valves (www.cranevalve.com) (Example: 373)
      b. Crane Company; Crane Valve Group; Jenkins Valves (www.jlvalve.com) (Example: 587J)
      c. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com).
      d. Hammond Valve. (www.hammondvalve.com)
      e. Kitz Corporation. (www.kitz.com)
      f. Legend Valve. (www.legendvalve.com)
      g. Milwaukee Valve Company. (www.milwaukeevalve.com)
      h. NIBCO Incorporated (www.nibco.com)
      i. Powell valves. (www.powellvalves.com)
      j. Red-White Valve Corporation. (www.redwhitevalvecorp.com)
      k. Sure Flow Equipment Incorporated. (www.sureflowequipment.com)
      l. Watts Regulator Co.; a division of Watts Water Technologies, Incorporated. (www.watts.com)
      m. Zy-Tech Global Industries, Incorporated.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Design: Clear or full waterway.
      e. Body Material: ASTM A 126, gray iron with bolted bonnet.
      f. Ends: Flanged.
      g. Trim: Bronze.
      h. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Crane Valves (www.cranevalve.com)
      b. Crane Company; Crane Valve Group; Jenkins Valves (www.jlvalve.com)
      c. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com).
      d. Hammond Valve. (www.hammondvalve.com)
      e. Milwaukee Valve Company. (www.milwaukeevalve.com)
      f. NIBCO Incorporated (www.nibco.com)
      g. Watts Regulator Co.; a division of Watts Water Technologies, Incorporated. (www.watts.com)
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.8 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Crane Valves (www.cranevalve.com)
      b. Crane Company; Crane Valve Group; Jenkins Valves (www.jlvalve.com)
      c. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com).
      d. Flo Fab Incorporated. (www.flofab.com)
      e. Hammond Valve. (www.hammondvalve.com)
      f. Kitz Corporation. (www.kitz.com)
      g. Legend Valve. (www.legendvalve.com)
      h. Milwaukee Valve Company. (www.milwaukeevalve.com)
      i. NIBCO Incorporated (www.nibco.com)
      j. Powell valves. (www.powellvalves.com)
      k. Red-White Valve Corporation. (www.redwhitevalvecorp.com)
      l. Watts Regulator Co.; a division of Watts Water Technologies, Incorporated. (www.watts.com)
      m. Zy-Tech Global Industries, Incorporated. (www.zycon.com)

   2. Description:
      a. Standard: MSS SP-70, Type I.
      b. NPS 4 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Disc: Solid wedge.
      h. Packing and Gasket: Asbestos free.

B. Class 250, OS&Y, Iron Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Crane Valves (www.cranevalve.com)
      b. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com).
      c. Hammond Valve. (www.hammondvalve.com)
      d. Milwaukee Valve Company. (www.milwaukeevalve.com)
      e. NIBCO Incorporated (www.nibco.com) (Example: F667-0)
      f. Powell valves. (www.powellvalves.com)
      g. Watts Regulator Co.; a division of Watts Water Technologies, Incorporated. (www.watts.com)

   2. Description:
      a. Standard: MSS SP-70, Type I.
      b. NPS 4 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Disc: Solid wedge.
      h. Packing and Gasket: Asbestos free.
2.9 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com). (Example: G 515)
      c. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example: F-2981-A)
      d. NIBCO Incorporated (www.nibco.com) (Example: F718-B)

B. Class 250, Iron Globe Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Company; Crane Valve Group; Stockham Division (www.stockham.com). (Example: F 532)
      b. Hammond Valve. (www.hammondvalve.com) (Example: IR313)
      c. Milwaukee Valve Company. (www.milwaukeevalve.com) (Example: 2983)
      d. NIBCO Incorporated (www.nibco.com) (Example: F768-B)

2. Description:
   a. Standard: MSS SP-85, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Packing and Gasket: Asbestos free.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install chain wheels on operators for globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 72 inches above finished floor.
F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION
A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

3.4 ADJUSTING
A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS
A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly valves.
   3. Throttling Service except Steam: Globe, ball, or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 3 and Smaller: Threaded ends.
   2. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Steel Piping, NPS 5 and Larger: Flanged ends.
   4. For Grooved-End Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.6 HEATING-WATER VALVE SCHEDULE
A. Pipe NPS 3 and Smaller:
   1. Ball Valves, NPS 3 and Smaller: Two piece, 600-psig CWP rating, copper alloy.
   2. Bronze Swing Check Valves: Class 125, bronze disc.
B. Pipe NPS 4 and Larger:
   3. High-Performance Butterfly Valves: Class 150, single flange.
   4. Iron Swing Check Valves: Class 125, metal seats.

END OF SECTION
SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

B. Related Sections:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   3. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
   4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.6 QUALITY ASSURANCE
A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot-dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      a. Allied Tube & Conduit. (www.alliedtube.com)
      b. Cooper B-Line, Inc. (www.cooperindustries.com)
      c. Flex-Strut Inc. (www.flexstrut.com)
      d. Thomas & Betts Corporation. (www.tnb.com)
      e. Unistrut Corporation; Tyco International, Ltd. (www.unistrut.com)
      f. Wesanco, Inc. (www.wesanco.com)
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   4. Channels: Continuous slotted steel channel with in-turned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Carpenter & Paterson, Inc. (www.carpenterandpaterson.com)
   3. ERICO International Corporation. (www.erico.com)
   5. PHS Industries, Inc. (www.phsind.com)
7. Piping Technology & Products, Inc. (www.pipingtech.com)

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic or Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, nuts, washers, and other accessories.


I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS
A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS
A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
3.4 ADJUSTING
A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING
A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting"; Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE
A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
F. Use stainless-steel pipe hangers and [stainless-steel attachments for hostile environment applications.
G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
H. Use padded hangers for piping that is subject to scratching.
I. Use thermal-hanger shield inserts for insulated piping and tubing.
J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION
SECTION 23 05 48
VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes HVAC piping and equipment vibration controls as herein specified.

1.3 SUBMITTALS
A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
B. Welding certificates.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATOR DESIGNATION
A. Refer to the following vibration isolator designation for description. See Equipment Isolation Schedule at end of this Section for type and deflection.
B. TYPE A SPRING MOUNTING WITH VERTICAL LIMIT STOPS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mason Industries.
      b. Peabody Noise Control Inc.
      c. Vibration Mountings & Controls.
   2. Free standing with sound deadening pads and leveling bolts with limit stops. Spring diameter-to-compressed operating spring height ratio – 1 to 1. Spring loaded minimum additional available travel – 50% of rated deflection.
C. TYPE B NEOPRENE AND SPRING
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mason Industries.
      b. Vibration Mountings & Controls.
   2. Combination spring and double deflection neoprene element in series. Spring diameter to compressed operating spring height ratio of 0.8 or greater. Spring loaded minimum additional available travel 50% of rated deflection. Spring diameter and hanger box hole large enough to permit hanger rod to swing through a 30 degree arc before contacting the box.
D. TYPE C SPRING
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mason Industries.
      b. Vibration Mountings & Controls.
2. Combination spring and double deflection neoprene hanger in series. Precompressed by the manufacturer to the rated deflection to keep piping or equipment at a fixed elevation during installation. Spring diameter to compressed operating spring height ratio of 0.8 or greater. Spring loaded minimum additional travel 50% of rated deflection. Spring diameter and hanger box hole large enough to permit hanger rod to swing through a 30 degree arc before contacting the box.

E. TYPE D RIGID BASE
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mason Industries.
   b. Peabody Noise Control Inc.
   c. Vibration Eliminator Co.
   d. Vibration Mountings & Controls.
2. Structural steel base tailored to accommodate the equipment, including electric motor slide base, with built-in isolator mounting brackets to minimize equipment mounting height. Minimum beam height to length ratio 10% but not less than 6”.

F. TYPE E INERTIA BASE
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mason Industries.
   b. Peabody Noise Control Inc.
   c. Vibration Eliminator Co.
   d. Vibration Isolation Co., Inc.
   e. Vibration Mountings & Controls.
2. Reinforced concrete inertia base tailored to accommodate the equipment, shipped ready to receive concrete, complete with welded steel frame, prelocated equipment anchor bolts and sleeves, electric motor slide base, integral height saving isolator mounting brackets, 1/2” re-bars welded on 6” centers both ways 1-1/2” above bottom. Minimum channel depth 1/12 the longest dimension but not less than 6”.

G. TYPE F VERTICAL PIPING ANCHOR AND GUIDE ISOLATORS
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mason Industries.
2. Acoustical pipe anchor and guide isolators consisting of telescopic arrangement of two sizes steel tubing separated by a minimum 1/2” thickness of heavy duty neoprene and duct or neoprene isolation material. Vertical restraints by similar method to prevent vertical travel in either direction. Allowable loads on the isolation material not to exceed 500 PSI with a balanced design for equal resistance in any direction.

H. TYPE G DUCTWORK SPRING ISOLATOR HANGERS:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mason Industries.
2. Spring type isolation hangers. Spring diameter minimum .8 of spring operating height. Minimum additional spring travel before going solid 50% of rated deflection. Spring diameter and hanger box lower hole large enough to permit hanger rod to swing through 30° arc before contacting box. Spring precompressed at factory by manufacturer. Furnish eye bolts for attachment to ductwork straps.

I. TYPE H VIBRATION ISOLATION ROOF CURB
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Thycurb, A Division of Thybar Corp.
2. Factory fabricated combination roof mounting curb and vibration eliminator base. The vibration eliminating portion of the assembly shall be constructed of structural steel and designed to match perfectly the bottom of the equipment. The roof curb shall be complete with wood nailing strip and continuous 8” rubber watertight counter flashing.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT ISOLATION
A. Provide hose or connector isolators on suction and discharge of all rotating and reciprocating equipment.
B. Mount close-coupled pumps on rails extended beyond the pump housing.
C. Provide horizontally split pump bases complete with base elbow supports at the discharge and suction.
D. Galvanize isolator body and cadmium plate isolator springs in outdoor applications.
E. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
F. Adjust active height of spring isolators.

3.3 PIPING ISOLATION
A. Isolate all piping connected to isolated mechanical equipment within the confines of the mechanical equipment room but for not less than 50’. Isolator types will be as follows:
B. Spring deflections - first 3 supports - equal to connected isolated equipment but not less than .75”. Balance of supports .75” deflection.
C. Floor mounted Type A.
D. Ceiling suspended Type C (first 3 supports) and Type B thereafter.
E. Adjust isolators after piping systems have been filled and equipment is at operating weight.
F. Adjust active height of spring isolators.

3.4 RISER ISOLATION
A. Suspend or support risers by Type F hangers or Type A mountings and anchor or guide risers with Type F isolators. Minimum spring deflections of .75” except in those expansion locations where additional deflection is required to limit deflection or load transfer to plus or minus 25% of initial stress.
B. Adjust active height of spring isolators.
3.5 DUCTWORK ISOLATION

A. Isolate all ductwork over 4” static pressure connected to isolated equipment within the confines of the mechanical equipment room but not less than 50’. Isolate from the building structure by means of Type G hangers or Type A floor mountings.

B. Adjust active height of spring isolators.

PART 4 - EQUIPMENT ISOLATION SCHEDULE

4.1 EQUIPMENT ISOLATION

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Location</th>
<th>Isolation Type</th>
<th>Total Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Air Handling Unit</td>
<td>Mechanical Rooms</td>
<td>C</td>
<td>1.0 inch</td>
</tr>
<tr>
<td>Suspended Air Conditioning Unit</td>
<td>Electric/Elevator Equipment Rooms, Occupied Areas, Data Rooms, UPS Rooms</td>
<td>C</td>
<td>1.0 inch</td>
</tr>
<tr>
<td>Suspended Exhaust Fan</td>
<td>Mechanical Rooms</td>
<td>C</td>
<td>1.0 inch</td>
</tr>
<tr>
<td>Compressor/Condenser Unit</td>
<td>Roof</td>
<td>B</td>
<td>2.5 inches</td>
</tr>
<tr>
<td>Compressor/Condenser Unit</td>
<td>Roof</td>
<td>H</td>
<td>2.5 inches</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   5. Duct labels.
   7. Valve tags.
   8. Warning tags.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification
   material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed
   content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.
F. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and
   include used stencils in maintenance materials.

1.4 QUALITY ASSURANCE
A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors and viewing angles of
   identification devices.

1.5 COORDINATION
A. Coordinate installation of identifying devices with completion of covering and painting of surfaces
   where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS
A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving,
      1/16 inch thick, and having predrilled holes for attachment hardware.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's unique equipment number.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Room numbers where equipment is indicated. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
C. Background Color: Black.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
F. Minimum Letter Size: 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction, complying with ANSI A13.1.
B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 PLASTIC TAPE

A. General: Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
B. Width: Provide 1-1/2 inches wide tape markers for pipes 6 inches or larger and provide 3/4 inch wide tape markers for pipes less than 6 inches.
C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.5 STENCILS
A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, acrylic enamel, black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS
A. Valve Tags: Stamped or engraved, 1-1/2 inches diameter, with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.
   2. For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of rigid plastic or extruded aluminum, with clear plastic glazing.

PART 3 - EXECUTION

3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.
C. Provide equipment labels for the following general categories of equipment and operational devices:
   1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
   2. Meters, gauges, thermometers and similar units.
   3. Fuel-burning units including boilers, furnaces, heaters, stills and absorption units.
   4. Pumps, compressors, chillers, condensers and similar motor driven units.
   5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.
   6. Fans, blowers, primary balancing dampers and mixing boxes.
   7. Packaged HVAC central-station and zone-type units.
   8. Tanks and pressure vessels.
   9. Strainers, filters, humidifiers, water treatment systems and similar equipment.
   10. Steam pressure reducing valve stations.
   11. Air compressors and vacuum pumps.
D. Provide the following sign for chilled water cooling coils with no glycol in the system: “Drain chilled water cooling coil when outdoor temperature reaches 35°F and blow out with compressed air. Flush with 50% ethylene glycol/water solution and blow out again.”

3.3 PIPE LABEL INSTALLATION
A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."
B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer’s option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
   1. Identification Paint: Use for contrasting background.
C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.4 DUCT LABEL INSTALLATION
A. Stenciled Duct Label: Stenciled labels, showing service and flow direction.
B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION
A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.6 VALVE SCHEDULE WITH FRAME INSTALLATION
A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 WARNING-TAG INSTALLATION
A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 CEILING GRIP AND ACCESS PANEL LOCATION TAGS
A. Provide adhesive stickers or tags on ceiling grids or access panels indicating locations of VAV boxes and hydronic shut-off valves.
B. Stickers or tags shall have 1/4-inch text size.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
      c. Primary-secondary hydronic systems.
   3. HVAC equipment quantitative-performance settings.
   4. Existing systems TAB.
   5. Verifying that automatic control devices are functioning properly.
   6. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS
A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
B. Balance: To proportion flows within the distribution system, including sub mains, branches, and terminals, according to indicated quantities.
C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
F. Report Forms: Test data sheets for recording test data in logical order.
G. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
H. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
I. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
J. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
K. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

N. TAB: Testing, adjusting, and balancing.

O. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

P. Test: A procedure to determine quantitative performance of systems or equipment.

Q. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.


T. TAB: Testing, adjusting, and balancing.


V. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

G. Sample Report Forms: Submit two sets of sample TAB report forms.

H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

I. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by either AABC or NEBB.
   1. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.
B. TAB Conference: Meet with Architect, Owners representatives and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days’ advance notice of scheduled meeting time and location.
   1. Agenda Items:
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.

C. Coordination of documentation and communication flow. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, “Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

H. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and under floor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 "Metal Ducts" Division 23 "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units; such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.
3.2 PREPARATION

A. Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work and prepare reports. Include, at a minimum, the following:
   1. General:
      a. Permanent electrical-power wiring is complete.
      b. Automatic temperature-control systems are operational.
      c. Windows and doors can be closed so indicated conditions for system operations can be met.
   2. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers’ startup is complete and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.
      i. Windows and doors are installed.
      j. Suitable access to balancing devices and equipment is provided.
      k. Equipment and duct access doors are securely closed.
   3. Hydronics:
      a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
      b. Piping is complete with terminals installed.
      c. Water treatment is complete.
      d. Systems are flushed, filled, and air purged.
      e. Strainers are pulled and cleaned.
      f. Control valves are functioning per the sequence of operation.
      g. Shutoff and balance valves have been verified to be 100 percent open.
      h. Pumps are started and proper rotation is verified.
      i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
      j. Variable-frequency controllers’ startup is complete and safeties are verified.
      k. Suitable access to balancing devices and equipment is provided.

3.3 CONSTRUCTION CHECKLIST

A. On projects with commissioning, contractor is responsible for utilizing the construction checklists supplied by the Commissioning Authority under Specification Section 019113, in accordance with the procedures defined for construction checklists.

3.4 FUNCTIONAL TESTING

A. On projects with commissioning, contractor is responsible for utilizing functional test procedures supplied by the Commissioning Authority under Specification Section 019113, in accordance with the procedures defined for functional test procedures.
3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 "Metal Ducts."

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
      1) Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
   d. Report the artificial loading of filters at the time static pressures are measured.
   e. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

3. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of submain and branch ducts.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Adjust submain branch duct volume dampers for specified airflows.
   3. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow
   3. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
      a. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   4. Re-measure each inlet and outlet after they have been adjusted.

E. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
   4. Mark all final settings.
   5. Test system in economizer mode. Verify proper operation and adjust if necessary.
   6. Measure and record all operating data.
   7. Record final fan-performance data.
3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
   2. Verify that the system is under static pressure control.
   3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer’s recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
      a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
      b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
      c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
      d. Adjust controls so that terminal is calling for minimum airflow.
      e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
         1) Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
         2) If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
      f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
   5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
      c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
      d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
      e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
   6. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report any artificial loading of filters at the time static pressures are measured.
   7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
      a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
      b. Verify that terminal units are meeting design airflow under system maximum flow.
   8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branchducts.

3.9 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils heat exchangers and other hydronic equipment with pertinent design data, and number in sequence starting at pump to end of system. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil, heat exchanger and other hydronic equipment flow rates with pump design flow rate. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing according to the following:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure
   3. Check flow-control valves for proper position as specified in sequence of operation, and set at indicated flow.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.
      a. Check air vents for a forceful liquid flow exiting from vents when manually operated. Open all manual valves for maximum flow.
   7. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
   8. Set system controls so automatic valves are wide open to heat exchangers.
   9. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   10. Check makeup water-station pressure gage for adequate pressure for highest vent.

3.10 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
   2. Measure pump TDH except for positive-displacement pumps as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gage heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
   1) If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and Owner and comply with requirements in Section 232123 "Hydronic Pumps."
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. Note the point on the manufacturer's pump curve.

4. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacture’s performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

B. Measure flow at all automatic flow control valve to verify that valves are functioning as designed.

C. Set calibrated balancing valves, if installed, at calculated pre-settings.

D. Adjust flow-measuring devices installed in mains and branches to within specified tolerance of design water flows.
   1. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
   2. Measure flow in main and branch pipes.
   3. Adjust main and branch balance valves for design flow.
   4. Re-measure each main and branch after all have been adjusted.
   5. Record settings and mark balancing devices.

E. Adjust flow-measuring devices installed at terminals for each space to within specified tolerances of design water flows.
   1. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
   2. Measure flow at terminals.
   3. Adjust each terminal to design flow.
   4. Re-measure each terminal after it is adjusted.
   5. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   6. Perform temperature tests after flows have been balanced.
   7. Record settings and mark balancing devices.

F. For systems with pressure-independent valves at terminals:
   1. Measure differential pressure and verify that it is within manufacturer's specified range.
   2. Measure flow at all pressure-independent control valves with valves in the fully open position to verify that valves are functioning as designed.
   3. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:
   1. Measure and balance coils by either coil pressure drop or temperature method.
   2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
   3. Record settings and mark balancing devices.

H. Verify final system conditions as follows:
   1. Re-measure, confirm and report final pump flow.
   2. Re-measure, confirm and report that total water flow is within design.
3. Re-measure and report final pumps’ operating data, TDH, volts, amps, rpm, and static profile.
4. Measure and report the final systems’ pressures and temperatures including outdoor-air temperature.
5. Mark final settings.

I. Mark final settings and verify that memory stops have been set.
J. Measure and report the differential-pressure-control-valve settings existing at the conclusion of balancing.
K. Check settings and operation of each safety valve. Record settings.

3.11 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:
1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:
1. Adjust pumps to deliver total design gpm.
   a. Measure total water flow.
      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
   b. Measure pump TDH except for positive-displacement pumps as follows:
      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gage heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
         (a) If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and Owner comply with requirements in Section 232123 "Hydronic Pumps."
      5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. Note the point on the manufacturer’s pump curve.
   d. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacture’s performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
2. Measure flow at all automatic flow control valve to verify that valves are functioning as designed.
3. Set calibrated balancing valves, if installed, at calculated pre-settings.
4. Adjust flow-measuring devices installed in mains and branches to within specified tolerance of design water flows.
   a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
   b. Measure flow in main and branch pipes.
c. Adjust main and branch balance valves for design flow.
d. Re-measure each main and branch after all have been adjusted.
e. Record settings and mark balancing devices.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
   b. Measure flow at terminals.
   c. Adjust each terminal to design flow.
   d. Re-measure each terminal after it is adjusted.
   e. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   f. Perform temperature tests after flows have been balanced.
   g. Record settings and mark balancing devices.

6. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Measure flow at all pressure-independent control valves with valves in the fully open position to verify that valves are functioning as designed.
   c. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
   c. Record settings and mark balancing devices.

8. Prior to verifying final system conditions, determine the system differential-pressure set point.

9. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

10. Mark final settings and verify that all memory stops have been set.

11. Verify final system conditions as follows:
    a. Re-measure, confirm and report final pump flow.
    b. Re-measure, confirm and report that total water flow is within design.
    c. Re-measure and report final pumps' operating data, TDH, volts, amps, rpm, and static profile.
    d. Measure and report the final systems' pressures and temperatures including outdoor-air temperature.
    e. Mark final settings.

12. Mark final settings and verify that memory stops have been set.

13. Measure and report the differential-pressure-control-valve settings existing at the conclusion of balancing.

14. Check settings and operation of each safety valve. Record settings.

D. For systems with diversity:
   1. Determine diversity factor.
   2. Simulate system diversity by closing required number of control valves, as approved by the design engineer. Note the control valves that were closed to maintain diversity.
   3. Adjust pumps to deliver total design gpm.
      a. Measure total water flow.
         1) Position valves for full flow through coils.
         2) Measure flow by main flow meter, if installed.
         3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
      b. Measure pump TDH as follows except for positive-displacement pumps as follows:
         1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
         2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights. 4)
5) Verify pump impeller size by measuring the TDH with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
6) If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and Owner and comply with requirements in Section 232123 "Hydronic Pumps."
7) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. Note the point on the manufacturer's pump curve.
   d. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacture's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Measure flow at all automatic flow control valve to verify that valves are functioning as designed.
5. Set calibrated balancing valves, if installed, at calculated pre-settings.
6. Adjust flow-measuring devices installed in mains and branches to within specified tolerance of design water flows.
   a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
   b. Measure flow in main and branch pipes.
   c. Adjust main and branch balance valves for design flow.
   d. Re-measure each main and branch after all have been adjusted.
   e. Record settings and mark balancing devices.
7. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
   b. Measure flow at terminals.
   c. Adjust each terminal to design flow.
   d. Re-measure each terminal after it is adjusted.
   e. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   f. Perform temperature tests after flows have been balanced.
   g. Record settings and mark balancing devices.
8. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Measure flow at all pressure-independent control valves with valves in the fully open position to verify that valves are functioning as designed.
   c. Perform temperature tests after flows have been verified.
9. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
   c. Record settings and mark balancing devices.
10. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened. Note the control valves that were closed to maintain diversity.
11. Prior to verifying final system conditions, determine system differential-pressure set point.
12. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
13. Mark final settings and verify that memory stops have been set.
14. Verify final system conditions as follows:
   a. Re-measure, confirm and report final pump flow.
   b. Re-measure and confirm that total water flow is within design.
   c. Re-measure final pumps' operating data, TDH, volts, amps, rpm, and static profile.
   d. Measure and report the final systems' pressures and temperatures including outdoor-air temperature.
   e. Mark final settings.
15. Mark final settings and verify that memory stops have been set.
16. Measure and report the differential-pressure-control-valve settings existing at the conclusion of balancing.
17. Check settings and operation of each safety valve. Record settings.

3.12 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS
A. Balance the primary circuit flow first.
   1. Balance the primary circuit for constant-flow or variable-flow hydronic systems as previously described.
B. Balance the secondary circuits after the primary circuits are complete.
   1. Balance the secondary circuits for constant-flow or variable-flow hydronic systems as previously described.

3.13 PROCEDURES FOR MOTORS
A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   4. Phase and hertz
   5. Efficiency rating.
   6. Nameplate and measured voltage, each phase.
   7. Nameplate and measured amperage, each phase.
   9. Service factor and frame size.
B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.14 PROCEDURES FOR CONDENSING UNITS
A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.15 PROCEDURES FOR HEAT-TRANSFER COILS
A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.
B. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.16 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   1. Measure and record the operating speed, airflow, and static pressure of each fan.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the refrigerant charge.
   4. Check the condition of filters.
   5. Check the condition of coils.
   6. Check the operation of the drain pan and condensate-drain trap.
   7. Check bearings and other lubricated parts for proper lubrication.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.
C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
   4. Balance each air outlet.

3.18 TOLERANCES
A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.19 PROGRESS REPORTING
A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As work progress prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT
A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.
2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
e. Filter static-pressure differential in inches w.g.
f. Preheat coil static-pressure differential in inches w.g.
g. Cooling coil static-pressure differential in inches w.g.
h. Heating coil static-pressure differential in inches w.g.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in sq. ft.
      h. Tube size in NPS.
      i. Tube and fin materials.
      j. Circuiting arrangement.
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Average face velocity in fpm.
      c. Air pressure drop in inches w.g.
      d. Outside-air, wet- and dry-bulb temperatures in degrees F.
      e. Return-air, wet- and dry-bulb temperatures in degrees F.
      f. Entering-air, wet- and dry-bulb temperatures in degrees F.
      g. Leaving-air, wet- and dry-bulb temperatures in degrees F.
      h. Water flow rate in gpm.
      i. Water pressure differential in feet of head or psig.
      j. Entering-water temperature in degrees F.
      k. Leaving-water temperature in degrees F.
      l. Refrigerant expansion valve and refrigerant types.
      m. Refrigerant suction pressure in psig.
      n. Refrigerant suction temperature in degrees F.
      o. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangement and class.
      g. Sheave make, size in inches, and bore.
      h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   2. Motor Data:
      a. Make and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches, and bore.
      f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches w.g.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
   e. Suction static pressure in inches w.g.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in degrees F.
   d. Duct static pressure in inches w.g.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in degrees F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in degrees F.
   c. Leaving-water temperature in degrees F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in degrees F.
f. Leaving-air temperature in degrees F.

K. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Compressor make.
   e. Compressor model and serial numbers.
   f. Refrigerant weight in lb (kg).
   g. Low ambient temperature cutoff in degrees F.

2. Test Data (Indicated and Actual Values):
   a. Inlet-duct static pressure in inches w.g.
   b. Outlet-duct static pressure in inches w.g.
   c. Entering-air, dry-bulb temperature in degrees F.
   d. Leaving-air, dry-bulb temperature in degrees F.
   e. Condenser entering-water temperature in degrees F.
   f. Condenser leaving-water temperature in degrees F.
   g. Condenser-water temperature differential in degrees F.
   h. Condenser entering-water pressure in feet of head or psig.
   i. Condenser leaving-water pressure in feet of head or psig.
   j. Condenser-water pressure differential in feet of head or psig.
   k. Control settings.
   l. Unloader set points.
   m. Low-pressure-cutout set point in psig.
   n. High-pressure-cutout set point in psig.
   o. Suction pressure in psig.
   p. Suction temperature in degrees F.
   q. Condenser refrigerant pressure in psig.
   r. Condenser refrigerant temperature in degrees F.
   s. Oil pressure in psig.
   t. Oil temperature in degrees F.
   u. Voltage at each connection.
   v. Amperage for each phase.
   w. Kilowatt input.
   x. Crankcase heater kilowatt.
   y. Number of fans.
   z. Condenser fan rpm.
   aa. Condenser fan airflow rate in cfm.
   bb. Condenser fan motor make, frame size, rpm, and horsepower.
   cc. Condenser fan motor voltage at each connection.
   dd. Condenser fan motor amperage for each phase.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model and serial numbers.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches (mm).
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

M. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.21 VERIFICATION OF TAB REPORT

A. Initial Verification:
   1. After testing and balancing are complete, operate each system and randomly check
      measurements to verify that the system is operating according to the final test and balance
      readings documented in the final report.
   2. Check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading
         to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. Final Verification:
   1. Architect, Owner and Commissioning Authority shall randomly select measurements,
      documented in the final report, to be rechecked. Rechecking shall be limited to either 10
      percent of the total measurements recorded or the extent of measurements that can be
      accomplished in a normal 8-hour business day.
   2. If rechecks yield measurements that differ from the measurements documented in the final
      report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   3. If the number of "FAILED" measurements is greater than 10 percent of the total measurements
      checked during the final inspection, the testing and balancing shall be considered incomplete
      and shall be rejected.
4. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report and request a second final inspection.

C. Prepare test and inspection reports.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION
SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.1 SUMMARY
A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
B. Related Sections:
   1. Section 230716 "HVAC Equipment Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.3 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
1.7 SCHEDULING
A. Schedule insulation application after pressure testing systems and, where required. Insulation application may begin on segments that have satisfactory test results.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FRK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; SOFTR All-Service Duct Wrap.
      f. Owens Corning; Fiberglas 700 Series.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FRK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Fibrex Insulations Inc.; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Insulation Board.
      e. Manson Insulation Inc.; AK Board.
      f. Owens Corning; Fiberglas 700 Series.

G. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Armacell LLC; Tubolit.
      b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
H. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 518, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.20 (R=5.0) Btu x in./h x sq. ft. x degrees F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585. Compressive strength 25 psi.

1. Products:
   a. Dow Chemical Company (The); Styrofoam.
   b. Knauf Insulation; Knauf Polystyrene.
   c. Owens Corning;

2.2 ADHESIVES
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75 K-Flex USA; R-373 Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:

   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.

E. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      d. Speedline Corporation; Polyco VP Adhesive.

2.3 FACTORY-APPLIED JACKETS
A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.4 FIELD-APPLIED JACKETS
A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Outdoor Jacket, Prefabricated, Self-Adhering, Sheet-Type Waterproofing Membrane: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located above-ground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film
covered with stucco-embossed aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Polyguard Products, Inc.; Alumaguard All Weather

C. Outdoor Jacket, Prefabricated, Self-Adhering, Sheet-Type Waterproofing Membrane Jacket: 3-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground; consisting of 5 layers of aluminum foil and polyester film.

1. Products:
   a. VentureClad 1577CW

2. Requirements:
   a. Tear Resistance, ASTM D 1424, 2 kg.
   b. Elongation, ASTM D 412, Minimum: 166 percent.
   c. Application temperature: minus 10°F to 248°F.
   d. Maximum Temperature; continuous use: 330°F.
   e. Water Vapor Transmission, ASTM E 96: 0 perms.
   f. Flame Spread Index, ASTM E 84: 0.
   g. Smoke Density Index, ASTM E 84: 0.
   h. Wind-Driven Rain, SFBC TAS-110-95, 100 mph: No leakage or failure.
   i. UV Stability: Excellent.

2.5 TAPES

A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.6 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.105-inch-diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:
      (a) AGM Industries, Inc.; CWP-1.
      (b) GEMCO; CD.
      (c) Midwest Fasteners, Inc.; CD.
      (d) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.105-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      (a) AGM Industries, Inc.; CHP-1.
      (b) GEMCO; Cupped Head Weld Pin.
      (c) Midwest Fasteners, Inc.; Cupped Head.
      (d) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Adhesive-backed base with a peel-off protective cover.

B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. AGM Industries, Inc.; RC-150.
      b. GEMCO; R-150.
      c. Midwest Fasteners, Inc.; WA-150.
      d. Nelson Stud Welding; Speed Clips.
   2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. GEMCO.
      b. Midwest Fasteners, Inc.
D. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

E. Wire: 0.062-inch soft-annealed, stainless steel.
   1. Products: Subject to compliance with requirements, provide one of the following:

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

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3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Section 078413 “Penetration Firestopping” and fire resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
   1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 “Penetration Firestopping.”
3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION
A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION
A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal center-line of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not over compress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
   6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal center-line of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over compress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:
   1. Factory-insulated flexible ducts.
   2. Factory-insulated plenums and casings.
   3. Flexible connectors.
   5. Factory-insulated access panels and doors.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, rectangular, round, and flat-oval, plenum and supply-air duct insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, rectangular, round, and flat-oval, plenum and supply-air duct located in unconditioned spaces, including the tunnel; insulation shall be the following:
   1. Mineral-Fiber Blanket: 3-inches thick and 0.75-lb/cu. ft. nominal density.
C. Concealed, rectangular, round, and flat-oval, plenum and return-air duct located in unconditioned spaces, including the tunnel; insulation shall be the following:
   1. Mineral-Fiber Blanket: 3-inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, rectangular, round, and flat-oval, plenum and outdoor-air duct insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.

E. Concealed, rectangular, round, and flat oval, plenum and exhaust-air duct insulation between isolation damper and penetration of building exterior (minimum length; 10-feet) shall be the following:
   1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.

F. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

G. Exposed, round and flat-oval, supply-air duct located in unconditioned spaces, including mechanical rooms: insulation shall be the following:
   1. Mineral-Fiber Blanket: 3-inches thick and 0.75-lb/cu. ft. nominal density.

H. Exposed, round and flat-oval, return-air duct located in unconditioned spaces, including mechanical rooms: insulation shall be the following:
   1. Mineral-Fiber Blanket: 3-inches thick and 0.75-lb/cu. ft. nominal density.

I. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 3-inches thick and 0.75-lb/cu. ft. nominal density.

J. Exposed, rectangular, plenum and supply-air duct insulation shall be the following:

K. Exposed, rectangular, supply-air duct located in unconditioned spaces, including mechanical rooms: insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

L. Exposed, rectangular, return-air duct located in unconditioned spaces, including mechanical rooms: insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

M. Exposed, rectangular, outdoor-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

N. Exposed, rectangular, round, and flat-oval, plenum and exhaust-air duct located with 10-feet of the exterior wall penetration; insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

O. Exposed, outdoor-air plenum insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes insulating the following HVAC equipment that is not factory insulated:
      1. Heating, hot-water pumps.
      2. Expansion/compression tanks.
      3. Air separators.
      4. Piping system filtration unit housings.
   B. Related Sections:
      1. Section 230713 "Duct Insulation."
      2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified Installer.
   B. Field quality-control reports.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
   B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
      1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION
   A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
   B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
   C. Coordinate installation and testing of heat tracing.
1.8 SCHEDULING
A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS
A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
F. Calcium Silicate:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Industrial Insulation Group (IIG); Thermo-12 Gold.
   2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Sheet and K-FLEX LS.
H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; SOFTR All-Service Duct Wrap.
I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Industrial Insulation Group (IIG); MinWool 1200 Flexible Batt.
      b. Johns Manville; HTB 26 Spin-Glas.
      c. Roxul Inc.; Roxul RW.
J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide the following:
   a. CertainTeed Corp.; CertaPro Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

K. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Fibrex Insulations Inc.; FBX. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
      b. Rock Wool; Delta Board.
      c. Roxul Inc.; RHT and RockBoard.
      d. Thermafiber, Inc.; Thermafiber Industrial Felt.

L. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000-Degree Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following:
      a. CertainTeed Corp.; CrimpWrap.
      b. Johns Manville; MicroFlex.
      c. Knauf Insulation; Pipe and Tank Insulation.
      d. Manson Insulation Inc.; AK Flex.
      e. Owens Corning; Fiberglas Pipe and Tank Insulation.

N. Phenolic:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Kingspan Tarec Industrial Insulation NV; Koolphen K.
      b. Resolco International BV; Insul-phen.
   2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
   3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

O. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Dow Chemical Company (The); Trymer 2000 XP.
      b. Duna USA Inc.; Corafoam.
      c. Dyplast Products; ISO-25.
      d. Elliott Company of Indianapolis; Elfoam.
2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E 84.

4. Fabricate shapes according to ASTM C 450 and ASTM C 585.

   a. Equipment Applications: PVDC-SSL.

P. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, provide the following:
   a. Armacell LLC; Tubolit.
   b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

2.2 MASS LOADED VINYL LAGGING

A. Composite limp vinyl sheet consisting of two layers of vinyl over a 1.4 psf barrier layer with a minimum STC rating of 28 and a 1" fiberglass batting decoupler layer.

B. Products
   1. Kinetics Noise Control KNM-100ALQ
   2. Acoustical Surfaces B-10 QFA-9
   3. Barymat BM-1C
   4. Engineer Approved Equal

C. Product Characteristics
   1. The barrier shall be constructed of a 0.12" thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side.
      a. Nominal density of barrier: 1.6 psf
      b. Minimum STC rating: 30
      c. Minimum Flammability rating per Federal Test Standard No. 191-5903:
         1) 0.0 seconds flame-out
         2) 0.2" char length
      d. NFPA 90A Flame Spread / Smoke Developed characteristics:
         1) Flame Spread: 10
         2) Smoke Developed: 40
      e. Minimum thermal conductivity barrier layer:
         1) K value of 0.29
      f. Rated service temperature range
         1) – 40 degrees F to 220 degrees F

2. Decoupler layer
   a. 1" fibrous glass batting
   b. Non-woven porous scrim-coated glass cloth
   c. Quilting
      1) 4" diamond stitch to encapsulate glass fibers

3. Seams
   a. 6" overlap tab for field joint sealing
      1) 54" nominal barrier width
      2) 48" nominal decoupler width

2.3 INSULATING CEMENTS


1. Products: Subject to compliance with requirements, provide the following:
   a. Ramco Insulation, Inc.; Super-Stik.
B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Ramco Insulation, Inc.; Thermokote V.

   1. Products: Subject to compliance with requirements, provide the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.4 ADHESIVES
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
   1. Products: Subject to compliance with requirements, provide the following:
      b. Eagle Bridges - Marathon Industries; 290.
      d. Mon-Eco Industries, Inc.; 22-30.
      e. Vimasco Corporation; 760.
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
C. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. Products: Subject to compliance with requirements, provide the following:
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Aeroflex USA, Inc.; Aerosel.
      b. Armacell LLC; Armaflex 520 Adhesive.
      d. K-Flex USA; R-373 Contact Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      d. Speedline Corporation; Polyco VP Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 75 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Products: Subject to compliance with requirements, provide the following:
      c. Vimasco Corporation; 713 and 714.
   3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
   4. Service Temperature Range: 0 to plus 180 deg F.
2.6 SEALANTS

A. Joint Sealants:

1. Products: Subject to compliance with requirements, provide the following:
   b. Eagle Bridges - Marathon Industries; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Permanently flexible, elastomeric sealant.

4. Service Temperature Range: Minus 100 to plus 300 deg F.

5. Color: White or gray.

6. For indoor applications, sealants shall have a VOC content of 75 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: Aluminum.

6. For indoor applications, sealants shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.


6. For indoor applications, sealants shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. Products: Subject to compliance with requirements, provide the following:
   1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
7. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
8. Products: Subject to compliance with requirements, provide the following:
   1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
10. Products: Subject to compliance with requirements, provide the following:

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide the following:
   a. Johns Manville; Zeston.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
4. Factory-fabricated tank heads and tank side panels.
D. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide the following:
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 2.5-mil-thick polysurlyn.
   d. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Outdoor Jacket, Prefabricated, Self-Adhering, Sheet-Type Waterproofing Membrane: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Polyguard Products, Inc.; Alumaguard All Weather

F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.

   1. Products: Subject to compliance with requirements, provide the following:
      a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor applications.
1. Products: Subject to compliance with requirements, provide the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide the following:
   a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
   2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.

B. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
   2. Products: Subject to compliance with requirements, provide the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
   3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   4. Products: Subject to compliance with requirements, provide the following:
      1) AGM Industries, Inc.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
   5. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
      a. Products: Subject to compliance with requirements, provide the following:
         1) GEMCO; Nylon Hangers.
         2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
      b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
      c. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
      d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   6. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
      a. Products: Subject to compliance with requirements, provide the following:
         1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers, Series.
         2) GEMCO; Peel & Press.
         3) Midwest Fasteners, Inc.; Self Stick.
      b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      c. Spindle: Aluminum, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
      d. Adhesive-backed base with a peel-off protective cover.
7. **Insulation-Retaining Washers**: Self-locking washers formed from 0.016-inch-thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

8. **Nonmetal Insulation-Retaining Washers**: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide the following:
      1) GEMCO.
      2) Midwest Fasteners, Inc.

2.11 **CORNER ANGLES**
A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

**PART 3 EXECUTION**

3.1 **EXAMINATION**
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **PREPARATION**
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 **GENERAL INSTALLATION REQUIREMENTS**
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Unless jackets with self-sealing layers are used, staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.
3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
      d. Do not overcompress insulation during installation.
      e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      f. Impale insulation over anchor pins and attach speed washers.
      g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
   7. Stagger joints between insulation layers at least 3 inches.
   8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
   9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
   10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
   1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
   2. Fabricate boxes from aluminum, at least 0.060 inch thick.
   3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal be- tween flanges with replaceable gasket material to form a vapor barrier.
3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Boiler Breechings:
   1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
   2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
   3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 INSTALLATION OF PHENOLIC INSULATION

A. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
B. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3.7 MASS LOADED VINYL LAGGING INSTALLATION

A. Cut sound control lagging material to length, wrapped around the outside of the pipe or duct to which the material is to be applied.
B. Fasten with mechanical fasteners or bands.
C. Tapes or adhesives for FSK jacketing shall be used in addition to the mechanical fasteners.
D. Install per manufacturer design guidelines.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.
B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer’s recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer’s recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:
   1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch circumference limit allows for 2-inch overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 FINISHES
   A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting.
   B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
   C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
   D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL
   A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 EQUIPMENT INSULATION SCHEDULE
   A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
   B. Insulate indoor equipment that is not factory insulated.
   C. Heating-hot-water expansion/compression tank insulation shall be one of the following:
      1. Mineral-Fiber Board: 1 inch thick and 3 lb/cu. Ft. density
   D. Heating-hot-water air-separator insulation shall be one of the following:
   E. Piping system filter-housing insulation shall be one of the following:
3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes insulating the following HVAC piping systems:
      1. Condensate drain piping
      2. Heating hot-water piping

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 QUALITY ASSURANCE
   A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
      1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
      2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION
   A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
   B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
   C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING
   A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
   B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
PART 2 - PRODUCTS

2.1 INSULATION MATERIALS


B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

1. Products: Subject to compliance with requirements provide one of the following:
   a. Industrial Insulation Group (IIG); Thermo-12 Gold. (www.iig-llc.com)
   b. Thermal conductivity (k-value) at 400 degrees F is 0.49 Btu x in. /h x sq. ft. x degrees F or less.
   c. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   d. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   e. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in pre-forming insulation to cover valves, elbows, tees, and flanges.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I, II with factory-applied vinyl jacket, III with factory-applied FSK jacket or III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements provide one of the following:
   a. CertainTeed Corporation; (www.certainteed.com)
   b. Johns Manville; Microlite. (www.jm.com)
   c. Knauf Insulation; (www.knaufinsulation.us)
   d. Manson Insulation Inc.; Alley Wrap. (www.isolationmanson.com)
   e. Owens Corning; SOFTR All-Service Duct Wrap. (commercial.owenscorning.com)

2. Thermal conductivity (k-value) at 150 degrees F is 0.27 Btu x in. /h x sq. ft. x degrees F or less.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200. (www.fibrex.com)
   b. Johns Manville; Micro-Lok. (www.jm.com)
   c. Knauf Insulation; 1000-Degree Pipe Insulation. (www.knaufinsulation.us)
   d. Manson Insulation Inc.; Alley-K. (www.isolationmanson.com)
   e. Owens Corning; Fiberglas Pipe Insulation. (commercial.owenscorning.com)

2. Type I, 850 degrees F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   a. Thermal conductivity (k-value) at 150 degrees F is 0.27 Btu x in. /h x sq. ft. x degrees F or less.
I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more.

1. Products: Subject to compliance with requirements provide one of the following:
   a. CertainTeed Corp.; CrimpWrap. (www.certainteed.com)
   b. Johns Manville; MicroFlex. (www.jm.com)
   c. Knauf Insulation; Pipe and Tank Insulation. (www.knaufinsulation.us)
   d. Manson Insulation Inc.; AK Flex. (www.isolationmanson.com)
   e. Owens Corning; Fiberglas Pipe and Tank Insulation. (commercial.owenscorning.com)

2. Thermal conductivity (k-value) at 150 deg F is 0.27 Btu x in. /h x sq. ft. x degrees F or less.

3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Phenolic:

1. Products: Subject to compliance with requirements provide one of the following:
   a. ITW Insulation Systems; Trymer Green. (www.itwinsulation.com)
   b. Kingspan Tarec Industrial Insulation NV; Koolphen K. (www.kingspantarec.com)
   c. Resolco International BV; Insul-phen. (www.resolco.com)
2. Thermal conductivity (k-value) at 75 degrees F is 0.15 Btu x in. /h x sq. ft. x degrees F or less.
3. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
4. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   a. Preformed Pipe Insulation: ASJ.

2.2 ADHESIVES

A. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 degrees F.

1. Products: Subject to compliance with requirements provide one of the following:
   b. Eagle Bridges - Marathon Industries; 290. (www.eaglebridges.com)
   d. Mon-Eco Industries, Incorporated (www.mon-ecoindustries.com)
   e. Vimasco Corporation; 760. (www.vimasco.com)
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 degrees F.

1. Products: Subject to compliance with requirements provide one of the following:
D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225. (www.eaglebridges.com)
      d. Mon-Eco Industries, Incorporated; 22-25. (www.mon-ecoindustries.com)

   1. Products: Subject to compliance with requirements provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225. (www.eaglebridges.com)
      d. Mon-Eco Industries, Incorporated; 22-25. (www.mon-ecoindustries.com)

F. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone. (www.dow.com)
      d. Speedline Corporation; Polyco VP Adhesive. (www.speedlinepvc.com)

2.3 MASTICS

A. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements provide one of the following:
      b. Vimasco Corporation; 749. (www.vimasco.com)
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 degrees F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements provide one of the following:
      b. Eagle Bridges - Marathon Industries; 501. (www.eaglebridges.com)
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   3. Service Temperature Range: 0 to 180 degrees F.
C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   1. Products: Subject to compliance with requirements provide one of the following:
         Encacel. (www.idccorp.com)
      b. Eagle Bridges - Marathon Industries; 570. (www.eaglebridges.com)
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company;
         60-95/96. (www.fosterproducts.com)
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 degrees F.
   4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Products: Subject to compliance with requirements provide one of the following:
         CP-10. (www.idccorp.com)
      b. Eagle Bridges - Marathon Industries; 550. (www.eaglebridges.com)
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company;
         46-50. (www.fosterproducts.com)
      e. Vimasco Corporation; WC-1/WC-5. (www.vimasco.com)
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 degrees F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.

2.4 SEALANTS

A. Joint Sealants:
   1. Products: Subject to compliance with requirements provide one of the following:
         CP-76. (www.idccorp.com)
      b. Eagle Bridges - Marathon Industries; 405. (www.eaglebridges.com)
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company;
         30-45. (www.fosterproducts.com)
      d. Mon-Eco Industries, Inc.; 44-05. (www.mon-ecoindustries.com)
      e. Pittsburgh Corning Corporation; Pittseal 444.
   2. Products: Subject to compliance with requirements provide one of the following:
         CP-70. (www.idccorp.com)
      b. Eagle Bridges - Marathon Industries; 405. (www.eaglebridges.com)
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company;
         30-45. (www.fosterproducts.com)
      d. Mon-Eco Industries, Inc.; 44-05. (www.mon-ecoindustries.com)
   3. Materials shall be compatible with insulation materials, jackets, and substrates.
   4. Permanently flexible, elastomeric sealant.
   5. Service Temperature Range: Minus 100 to plus 300 degrees F.
   6. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements provide one of the following:
         CP-76. (www.idccorp.com)
      b. Eagle Bridges - Marathon Industries; 405. (www.eaglebridges.com)
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44. (www.fosterproducts.com)
d. Mon-Eco Industries, Inc.; 44-05. (www.mon-ecoindustries.com)

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 degrees F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements provide one of the following:
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 degrees F.

2.5 FACTORY-APPLIED JACKETS
A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
   5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   6. Products: Subject to compliance with requirements provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film. (www.dow.com)
   7. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   8. Products: Subject to compliance with requirements provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film. (www.dow.com)
   10. Products: Subject to compliance with requirements provide one of the following:
       1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film. (www.dow.com)
   11. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 FIELD-APPLIED JACKETS
A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354- C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements provide one of the following:
   a. Johns Manville; Zeston. (www.jm.com)
   c. Proto Corporation; LoSmoke. (www.protocorporation.com)
   d. Speedline Corporation; SmokeSafe. (www.speedlinepvc.com)
2. Adhesive: As recommended by jacket material manufacturer.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degrees, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ. (www.abitape.com)
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836. (www.stus.averydennison.com)
      c. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ. (www.venturetape.com)
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements provide one of the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK. (www.abitape.com)
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827. (www.stus.averydennison.com)
      c. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ. (www.venturetape.com)
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements provide one of the following:
      a. ABI, Ideal Tape Division; 370 White PVC tape. (www.abitape.com)
      b. Venture Tape; 1506 CW NS. (www.venturetape.com)
   2. Width: 2 inches.
   3. Thickness: 6 mils.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.
D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements provide one of the following:
      a. ABI, Ideal Tape Division; 488 AWF. (www.abitape.com)
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
         (www.stus.averydennison.com)
      c. Venture Tape; 3520 CW. (www.venturetape.com)
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements provide one of the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals. (www.itwinsulation.com)
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs. (www.rphouston.com)
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick,
      1/2 inch or 3/4 inch wide with wing seal or closed seal.
   3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept
      metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.
   1. Products: Subject to compliance with requirements provide one of the following:

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and
   other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will
   adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free
   of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for
   each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install
   accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry
   state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistant joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation
by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
   4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
   3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   2. Install insulation to flanges as specified for flange insulation application.
   3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
   1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
   2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.10 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Underground piping.

3.11 INDOOR PIPING INSULATION SCHEDULE
A. Condensate and Equipment Drain Water below 60 Degrees F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Heating-Hot-Water Supply and Return, 105 degrees to 140 degrees F:
   1. NPS 1.5 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1.5-inches thick.
   2. NPS 2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I, 2-inches thick.

C. Heating-Hot-Water Supply and Return, 141 degrees to 200 degrees F:
   1. NPS 1.25 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1.5-inches thick.
   2. NPS 1.5 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I, 2-inches thick.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION
A. The requirements of this section apply to all sections of Division 23.
B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Division 1 Section "General Commissioning Requirements." The commissioning process, which the Contractor is responsible to execute, is defined in Division 1 Section "General Commissioning Requirements." A commissioning agent (CxA) will manage the commissioning process.

1.2 RELATED WORK
A. Division 1 Section "General Requirements."
B. Division 1 Section "General Commissioning Requirements."
C. Division 1 Section "Shop Drawings, Product Data, and Samples."

1.3 SUMMARY
A. This section includes requirements for commissioning HVAC systems, subsystems, and equipment. This section supplements the general requirements specified in Division 1 Section "General Commissioning Requirements."
B. The commissioning activities have been developed to support requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
C. Refer to Division 1 Section "General Commissioning Requirements" for more specifics regarding processes and procedures as well as roles and responsibilities for all commissioning team members.

1.4 DEFINITIONS
A. Refer to Division 1 Section "General Commissioning Requirements" for definitions.

1.5 COMMISSIONED SYSTEMS
A. Commissioning of a system or systems specified in this division is part of the construction process. Documentation and testing of these systems, as well as training of the operations and maintenance personnel, is required in cooperation with the Commissioning Agent.
B. The following HVAC systems will be commissioned:
   1. Air handling systems including terminal units.
   2. DX cooling systems.
   3. Direct digital control system.
   4. Heating hot water systems.
   5. Exhaust fans.
   6. Computer room HVAC systems.

1.6 SUBMITTALS
A. The commissioning process requires review of selected submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the engineer prior to forwarding to the Contractor. Refer to Division 1 Section "Shop Drawings, Product Data, and Samples" for further details.
The commissioning process requires submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Division 1 Section "General Commissioning Requirements."

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete pre-functional checklists to verify that systems, subsystems, and equipment installation is complete and systems are ready for systems functional performance testing. The Commissioning Agent will prepare pre-functional checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the engineer and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists also is inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Division 1 Section "General Commissioning Requirements" for submittal requirements for Pre-functional checklists, equipment startup reports, and other commissioning documents.

3.2 CONTRACTOR TESTS

A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Division 1 Section "General Requirements." The Commissioning Agent will witness selected contractor tests. Contractor tests shall be completed prior to scheduling systems functional performance testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. The commissioning process includes systems functional performance testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed systems functional performance test procedures for review and approval by the resident engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Division 1 Section "General Commissioning Requirements" for additional details.

3.4 TRAINING

A. Training of operations and maintenance personnel is required in cooperation with the resident engineer and Commissioning Agent. Provide competent, factory-authorized personnel to provide instruction to operations and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the resident engineer after submission and approval of formal training plans. Refer to Division 1 Section "General Commissioning Requirements" and Division 23 sections for additional Contractor training requirements.

END OF SECTION
SECTION 23 09 50
CONTROL STANDARD FOR BACNET INTEGRATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 WORK COVERED BY THIS SECTION
A. Provide updates and upgrades to the existing Johnson controls DDC building management system for the remodel work. For equipment remaining, the DDC components shall be reused and reconfigured as needed for proper operation of the systems. Provide new components for the equipment being installed. Controls contractor to verify components are operational prior to start of construction, and notify owner if not operational.
B. Provide updates to the DDC system graphics to correspond with the new building system equipment components and systems equipment. Identification and room schedule shall match the construction drawings.
C. DDC components to be removed are to be turned over to the owner for their use.
D. Coordinate with mechanical contractor for shutdown and startup of equipment to remain.
E. Furnish all labor materials, equipment, service and training necessary for a complete, operational, and fully commissioned direct digital control (DDC) system for the facilities identified in the contract documents. The system shall use the BACnet protocol ANSI/ASHRAE 135-2008 at the IP level of the architecture. Conformance under ANSI/ASHRAE 135-2008, 135-2010 and 135-2012 is also acceptable. Web services at the supervisory controller and/or PC server level is also required. See Appendix G for a complete list of Web Services requirements.
F. Furnish all labor, materials, equipment, service, and training necessary to integrate the proposed DDC system into the existing Hennepin County Control Securities Operations Center (SOC) BACnet alarm receiver. The primary communications protocol used by Hennepin County is BACnet/IP at the Supervisory controller and Web services from the vendor specific PC web server. Existing LON and BACnet MS/TP may be used at the inter building level only, provided that the supervisory controllers communicate using BACnet/IP on the existing Hennepin County LAN which is Ethernet based. Adding new LON components is allowed by exception only.
G. The controls contractor shall include all items, which are reasonably necessary to complete the installation even though not specifically mentioned in the Contract Documents.
H. Temperature control panels and/or enclosures in equipment rooms shall be located at readily accessible locations approved by Hennepin County’s Owner Representative.
I. The control system “As-Built” drawings that show all devices and wiring and the sequence of operation shall be accessible through links on the Web Browser graphic page.
   1. Hennepin County owns and operates a Securities Operation Center (SOC) which provides central monitoring of HVAC systems, fire, security and life safety systems, for approximately 70 County owned facilities. Each addition and/or alteration to a building control system shall work on the Hennepin County LAN utilizing BACnet/IP as the primary inter building protocol.
   2. The SOC is presently located at: Hennepin County Government Center.
J. Hennepin County DDC Network
   1. Hennepin County owns and operates a dedicated mixed-mode network (fiber and copper) for building-to-building communications. This network is not dedicated to the fire, security and building control systems. Temperature Control Contractors must work directly with the County IT department to acquire access to the County LAN. It is the responsibility of the Controls Contractor to ensure that all County’s IT requirements are met before any Ethernet based DDC system is bid.
2. All building level devices must communicate using BACnet/IP and must support the requirements listed in this specification. Hennepin County is committed to integration so that point status and automatic control and alarming can be channeled into a common protocol. Hennepin County has established BACnet/IP and existing LON or BACnet MS/TP as the common protocol.

K. Hennepin County DDC System Functions
   1. The general categories of the automated capabilities of Hennepin County DDC system are:
      a. Monitoring and Scheduling: Includes starting, stopping, observing, and reporting the operating status.
      b. Intervention: The ability to automatically or manually shift to an alternate operating mode when conditions warrant it from a remote location.
      c. Integration: The ability to coordinate the operation of several systems within a building, or several buildings, to ensure efficient operation.
      d. Management Information: The ability to provide cumulative operating data such as system run time, units of energy consumed, and preventive maintenance schedules.

2. All DDC systems must be capable of functioning in the following modes:
   a. All life safety and building system objects shall be monitored and controlled, including equipment scheduling, via (BACnet/IP).
   b. System alarms shall be transmitted from each BACnet Supervisory controller to a BACnet recipient using intrinsic and/or algorithmic (event enrollments) alarming methods.

3. Hennepin County personnel shall have the ability to: control set point, alarm limit and time schedule program modifications from the BAS workstation or through any third party BACnet/IP workstation.

L. BACnet Integration:
   1. Due to the complexity and size of Hennepin County BACnet system, integration requires stringent cooperation between Hennepin County Facility Services and the selected Temperature Controls Contractor. Hennepin County requires direct communication with the manufacturer's highest level of customer support, and may need to converse with the manufacturer's BACnet development team during project design, implementation, commissioning, and warranty phases.

   2. Hennepin County is committed to integrating different manufacturer’s temperature control systems on a common LAN for all existing and future temperature control systems that may be installed. Hennepin County BACnet required conformance is limited to B-Side or BACnet building controllers, only. The Temperature Controls Contractor must provide labor, software, materials, wiring, network coordination and expertise to install Web Based BACnet Building Controllers and/or BACnet MS/TP field level controllers.

   3. Bidding Controls Contractors must install control devices that have been pre-approved by Hennepin County. Refer to Appendix A for the listing of pre-approved controllers.

   4. BACnet/Web Services communication shall be via the Hennepin County LAN directly from the building level controllers or vendor information PC server without having to route or convert it from a proprietary source. When building level network controllers are used for core BACnet communications, the field level panels on its sub LAN, such as VAVs and unitary level controllers, can utilize BACnet MS/TP.

   5. Building level network controllers shall have the same model/part number and major firmware revision as the pre-approved controllers listed in Appendix A.

   6. Contractor shall provide current BACnet Interoperability Building Blocks (BIBBs) and PICs Statements with a written request to approve new BTL Listed BACnet controllers or major firmware revisions that are not currently preapproved and are not listed in Appendix A. Hennepin County will determine if the new controllers are acceptable for use on Hennepin County projects. Until such time that new controllers or firmware revisions are added to the preapproved controls list (Appendix A), they shall not be used on Hennepin County projects.

   7. BACnet conformance disputes that may arise in the Temperature Control Contractors installed BACnet Building Controller shall be resolved by the temperature controls Contractor working directly with the temperature controls manufacturer. Cost of translation between non-English speaking testers, developers and customer support personal whether overseas or in the USA will
be the responsibility of the Controls Contractor. On site device testing will be conducted using the BACnet Manufacturers Association / BACnet Testing Laboratories (BMA/BTL) Virtual Test Shell 3.6.5 (VTS) program. Virtual Test Shell (VTS) is an application for testing the BACnet functionality of various devices used in building automation systems. Conformance issue fault will be agreed on and resolved using ANSI/ASHRAE Standards 135-2008 publication.

8. No Gateways, Communication Bridges, Protocol Translators or any other device that translates any proprietary or other communication protocol to the BACnet communication protocol shall be permitted as a part of the BAS installation pursuant with this specification section. Gateways may only be used as required for communication to existing systems or systems installed pursuant with other specific sections.

1.3 DEFINITION OF TERMS/ACRONYMS/ABBREVIATIONS

A. Additional definitions of terms or acronyms are included on the contract drawings and in other sections of this specification.

B. In the preparation of submittals and reports, the contractor shall use these definitions and abbreviations. Any terms or abbreviations used by the contractor in submittals and reports that have not been defined in this section shall be defined by the Contractor in the first section of the submittal or report prior to their use.

C. The following definitions serve as a guide for industry acronyms in the coming sections:

1. ANSI - American National Standards Institute
2. ASHRAE - American Society of Heating Refrigeration and Air Conditioning Engineers
3. BACnet - Building Automation and Controls Network
4. BAC/IP – BACnet communications protocol via IP
5. BIBBs - BACnet Interoperability Building Blocks
6. BMA – BACnet Manufacturers Association
7. BTL – BACnet Testing Laboratories
8. CSV – Comma Separated Value
9. DDC - Direct Digital Controls
10. EIA - Electronic Industries Association
11. IP – Internet Protocol
12. ISO - International Standards Organization
13. LAN - Local Area Network
14. LON - Local Operating Network
15. LONTalk - Open, published protocol
16. LONWorks - A set of tools and components
17. NIST - National Institute of Standards and Technology
18. PIC - Protocol Implementation Conformance Statement
19. VAV - Variable Air Volume
20. SOC – Security Operations Center

1.4 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)
2. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
3. AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR-CONDITIONING ENGINEERS (ASHRAE)
4. ASHRAE 135-2008 BACnet Standard
5. FEDERAL COMMUNICATIONS COMMISSION (FCC)
6. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
7. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
8. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
9. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
10. UNDERWRITERS’ LABORATORIES (UL)
1.5 SUBMITTALS

A. Upon acceptance of a proposal, the controls Contractor will provide submittal drawings for approval prior to ordering any equipment.

B. Copies of all required software shall be submitted to the Owner prior to the start of construction. No payroll applications will be approved until all required software has been received. Software includes all software needed to program all system components including PC applications, graphic creation, supervisory and sub controllers.

C. A work schedule (implementation plan) shall be presented to the Owner before the start of work.
   1. All work shall be scheduled with the Owner to minimize building interruptions.
   2. Any service interruptions for making connections to the existing system shall be scheduled in advance with the Owner and only during periods approved by the Owner.
   3. The schedule shall include a timeline for hardware changes, software programming, communication connections, training, projected completion dates, etc.

D. If a conflict, error, omission or lack of detailed description is discovered in the Contract Documents, the controls Contractor shall immediately notify the Engineer and Owner and request clarification. The Engineer and Owner will resolve the conflict and make any corrections or interpretations necessary to fulfill the intent of the plans and specifications.

E. Shop drawings shall be 11 inch by 17 inch, landscape, bound on the left edge. Organize the packages by building. All documents shall be submitted electronically in portable document format (PDF). At the request of the Owner, shop drawings will also be submitted in the native CAD format.

F. All text based documents and product data sheets shall be 8 ½ inch by 11 inch format bound on the left edge. All documents shall be submitted electronically in portable document format (PDF).

G. Software files shall be submitted on fully labeled CDs that shall include a table of contents file in PDF format that provides a description of all of the files on the CD.

H. Submittals Prior To Construction
   1. Shop Drawings - System Architecture Design Diagram
      a. Riser Diagram shall show the IP layer and all of the Building Level Net layers.
      b. Riser Diagram shall show each computer, printer, router, repeater, controller, and protocol translator (for existing equipment only) that is connected to either the IP layer or any of the Building Level Net sub controllers.
      c. Where applicable, the Riser Diagram shall include the existing control system that is to be integrated into the new system.
      d. Each component that is shown shall have a name that is representative of how it will be identified in the completed database and the manufacturer’s name and model number.
      e. The physical relationship of one component to another component shall reflect the proposed installation.
      f. Riser Diagram shall not include power supplies, sensors or end devices.
   2. Layout Design Drawing for each control panel:
      a. The layout drawing shall be to scale with all devices shown in their proposed positions.
      b. All control devices shall be identified by name.
      c. All terminal strips and wire channels shall be shown.
      d. All control transformers shall be shown.
      e. All 120 VAC receptacles shall be shown.
      f. All IP connection points shall be shown.
   3. Wiring Design Diagram for each control panel.
      a. The control voltage wiring diagram shall clearly designate devices powered by each control transformer. The diagram shall clearly show the consistent grounding of the appropriate power connection. All wire identification numbers shall be annotated on the diagram.
      b. The sub controller wiring diagram shall clearly show the use of the daisy chain wiring concept, the order in which the devices are connected to the building bus, and the location...
of end of segment termination devices. All wire identification numbers shall be annotated on the diagram.

c. If shielded communication wiring is used, the grounding of the shield shall be shown.

d. The terminal strip wiring diagram shall identify all connections on both sides of the terminal strip. Wiring label numbers for all wiring leaving the control panel shall be annotated on the diagram.

e. Where pneumatic devices are monitored or controlled by the DDC systems, the control panel wiring diagrams shall include pneumatic piping diagrams for all components.

4. Wiring Design Diagram for each control panel.
   a. The wiring diagram for each component shall identify all I/O, power, and communication wiring and the locations on the terminal blocks to which the wires are landed.
   b. Installation Design Detail for each I/O device. A drawing of the wiring details for each sensor and/or end device. For devices with multiple quantities, a standard detail may be submitted.

5. System Flow Design Diagram for each controlled system.
   1) A two dimensional cross sectional diagram showing key components such as fans, coils, dampers, valves, pump, etc.
   2) Identify the locations and names of all sensors and end devices that are associated with the control system. Label the panel name and terminal numbers where the connections are landed.
   3) A legend shall be provided for all symbols used.

6. Alarm Matrix
   a. Alarm Matrix that lists all building alarm points.
   b. The matrix shall identify an alarm class for each alarm point.

7. Data
   a. Direct Digital Control System Hardware Technical Data.
      1) A complete bill of materials of equipment to be used indicating quantity, manufacturer, and model number.
      2) Manufacturer’s description and technical data for each unique device to include performance curves, product specification sheets, and installation instructions. When a manufacturer’s data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.
      3) This requirement applies to:
         (a) Controllers
         (b) Transducers/Transmitters
         (c) Sensors
         (d) Actuators
         (e) Valves
         (f) Relays and Switches
         (g) Control Panels
         (h) Power Supplies
         (i) Batteries
         (j) Operator Interface Equipment

8. An Instrumentation List for each controlled system.
   a. The list shall be in a table format.
   b. Include name, type of device, manufacturer, model number, and product data sheet number.

9. Sequence of Control: A sequence of control for each system being controlled. Include the following as a minimum.
   a. Process control sequence for each end device.
   b. Supervisory logic sequence of control for each system.
   c. The impact of each global application program on the sequence of control (Example: Demand Control).
   d. A list of all physical inputs and outputs associated with each sequence.
e. Within the sequence of control, all application parameters that are to be user adjustable from an operator workstation (OWS) shall be annotated with (adj) after the name of the parameter. This shall include set points, reset schedule parameters, calibration offsets, timer settings, control loop parameters such as gain, integral time constant, sample rates, differentials, etc.

f. All points that shall be subject to manual control from an OWS.

g. A list of all alarm points, a description of the alarm and a description of the alarm criteria.

9. Binding Map (to ensure distributed processing)
   a. A list of the device-to-device (peer-to-peer) data flow. This shall not include the flow of data from devices to the OWS.
   b. Include:
      1) Description of the variable.
      2) Sending device.
      3) Receiving device.

I. Submittals During Construction
   1. Training Manuals for each Training Course
      a. Submit the following four weeks in advance of the training:
         1) List of training objectives.
         2) Outline of the course with time allocations per topic.
         3) Training presentation material (slides, word documents, etc.).
         4) Copy of training reference material (product manuals to be used, etc.).
         5) Schematic of the training equipment to be used with model numbers on each component.
         6) A description of the measurement devices to measure training effectiveness (quizzes, programming exercises, course exam).
         7) Instructor’s name and resume with an emphasis on experience in presenting training programs.
   
   2. Startup Testing Plan: Submit a start-up testing plan for each unique system.
      a. The purpose of a startup test is to demonstrate the completeness of the physical tasks associated with installation and the performance of the components.
      b. For each task on the startup test checklist, the plan shall require the technician to enter their initials and the date the test was completed along with any recorded data such as voltages, offsets, or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.
      c. Required elements of the startup testing include:
         1) Measurement of voltage sources, primary and secondary.
         2) Verification of proper controller power wiring.
         3) Verification of component inventory when compared to the submittals.
         4) Verification of labeling on components and wiring.
         5) Verification of connection integrity and quality (loose strands and tight connections).
         6) Verification of bus topology, grounding of shields and installation of termination devices.
         7) Verification of point checkout.
      d. Each I/O device is landed per the submittals and functions per the sequence of control.
      e. Analog sensors are properly scaled and a value is reported.
      f. Binary sensors have the correct normal position and the state is correctly reported.
      g. Analog outputs have the correct normal position and move full stroke when so commanded.
      h. Analog outputs shall be tested to verify that any controlled pneumatic devices travel full stroke when the AO is varied from 0% to 100% output.
      i. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
         1) Documentation of analog sensor calibration (measured value, reported value and calculated offset).
         2) Documentation of Loop tuning (sample rate, gain and integral time constant).
      j. Submit at least two weeks prior to equipment startup.
3. Startup Testing Report
   a. Startup testing reports shall be submitted on a per system basis.
   b. Startup testing reports shall be the documented results of the executed startup testing plans.

4. Graphic Pages: Submit a sample graphic page for each type of page described in the specification section on graphic pages.

J. Submittals After Construction
   1. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as “As-Built”. As-Built drawings will each be stamped “As-Built” and have the as-built date on them. The As-Built drawings will contain at a minimum:
      a. System architecture drawing.
      b. Detailed drawings for each piece of controlled and monitored equipment
         1) Layout drawing for each control panel.
         2) Wiring diagram for each control panel.
         3) Wiring diagram for individual components.
         4) Objects list.
         5) Room Schedules.
         6) Sequence of operation.
         7) Hardware with part number information.
         8) System flow diagram for each controlled system.
      c. Detailed routing of all communication trunk wires (building-to-building and within building), locations of all network and integration devices, front-end workstations, UPS and building network/LAN connections.
      d. Binding map.
   2. Operation and Maintenance Manuals
      a. The controls contractor shall provide one electronic (PDF) copy and three (3) bound copies of Operation and Maintenance Manuals.
      b. Deliver manuals to the Engineer and Hennepin County project manager.
      c. Manuals shall be bound in heavy-duty, vinyl-covered, three-post, loose-leaf binders, permanently labeled on front and spine of each binder.
      d. Arrange the manuals according to specification section numbers used in the Project Manual; include a table of contents that identifies the responsible installing contractor, contact person, and telephone number with area code and thumb tab index sheets.
      e. Provide pocket folders for folded sheet information.
      f. Maintenance and Operating Manual shall include the following type of information:
         1) One copy of the executed Certificate(s) of Substantial Completion. This document will be used to communicate to all necessary Hennepin County personnel the starting date of the one-year Warranty period.
         2) Signed record copy of bonds, guarantees, and warranties required by the Contract Documents.
         3) Manufacturer’s required preventative maintenance inspections, testing, service, lubrication, maintenance instructions, and schedules.
         4) Parts lists and local service organization.
         5) As-built wiring and piping diagrams.
         6) System architecture diagram for components within the building annotated with specific location information.
         7) As-built drawing for each control panel.
         8) As-built wiring design diagram for each control panel.
         9) As-built wiring design diagram for all components.
         10) Installation design details for each I/O device.
         11) As-built system flow diagram for each system.
         12) Sequence of control for each system.
         13) Room schedules.
         14) Binding map for the building.
         15) Product data sheet for each component.
         16) Installation data sheet for each component.
         17) Other information required by the Specifications.
g. The Contractor shall instruct Hennepin County personnel in the use of Maintenance and Operating Manuals.

3. Software
   a. Submit a copy of all software installed on the servers and workstations.
   b. Submit all licensing information for all software installed on the servers and workstations.
   c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
   d. Submit all licensing information for all of the software used to execute the project.

K. Project Closeout Submittals:
   1. The Temperature Controls Contractor shall advise the Owner throughout the duration of construction as to the status of the contract closeout submittals including, but not limited to, the ongoing development of the maintenance and operations manuals and record documents.

1.6 OWNERSHIP OF PROPRIETARY MATERIAL
   A. Hennepin County shall retain all rights to software for this project.
   B. Hennepin County shall sign a copy of the manufacturer’s standard software and firmware licensing agreement as a condition of this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer’s license agreement, but shall protect the manufacturer’s rights to disclosure of Trade Secrets contained within such software.
   C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner’s computers and only for the purpose of commissioning, servicing, or altering the installed system.
   D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
      1. Server and Workstation software
      2. Application Programming Tools
      3. Configuration Tools
      4. Addressing Tools
      5. Application Files
      6. Configuration Files
      7. Graphic Files
      8. Report Files
      9. Graphic Symbol Libraries
     10. All Documentation.

PART 2 PRODUCTS

2.1 MANUFACTURERS
   A. Approved Manufacturers:
      1. Hennepin County conducted control system prequalification testing for BACnet integration and has published a list of approved control devices in Appendix A. Only pre-approved control devices listed in Appendix A shall be proposed and installed on Hennepin County projects.
      2. Building level network controllers shall have the same model/part number and firmware revision as the pre-approved controllers listed in Appendix A.
      3. Control Contractors shall provide all of the “Requirements for use at Hennepin County Buildings” from Appendix A for their approved controllers.
      4. Approved Manufacturers that do not currently have virtualized Web Server supervisor software on the Hennepin County network must include the cost of furnishing and installing Web Server supervisor software in their proposed cost. All Hennepin County network security, software license and installation requirements shall apply to the Web Server software.
B. Approved BAS Installation Contractors
   1. Johnson Controls – 2605 Fernbrook Lane North, Suite T, Plymouth, MN 55447

2.2 SYSTEM ARCHITECTURE
A. The DDC system architecture shall consist of three layers: the IP layer devices, the Building Level Net devices and Web services devices.
B. All new building controllers, PCs and IP devices will be connected to the Hennepin County LAN. The LAN connection shall be coordinated with Hennepin County IT personal. The Temperature Control Contractor shall be responsible for all inner building wiring. Hennepin County IT Dept will provide a single RJ-45 Ethernet connection point in the building. All internal building communications wire shall be supplied and installed by Temperature Control Contractor.
C. BACnet Building Controllers (B-BC) shall be used to connect each Building Level Net to the IP layer.

2.3 NETWORKING
A. IP Network: All devices that connect to the County LAN shall be capable of operating at 100 megabits per second.
B. IP-to-Building Level Net Routing Devices:
   1. BACnet Building Controller (Supervisory Controller) shall be used to provide this functionality.
   2. These devices shall be configurable locally with EIA-232, IP connection or USB communications.
   3. The routing configuration shall be such that only data packets from the Building Level Net devices that need to travel over the IP level of the architecture are forwarded. Additionally, data packets from the IP level that need to travel to the sub LAN devices will be forwarded. BACnet ‘Who is’ and ‘Who has’ global and local broadcast messages should be answered by the supervisory controller as a proxy whenever possible. It is the intention of the County to minimize network traffic between supervisory controllers and Building Level Net devices using BACnet MS/TP protocol.
C. Building Level Net
   1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology. Building Level Net device programming must be accessible via pass through from supervisory controller. Disconnecting Building Level Net for the purpose of programming sub controllers is prohibited.
D. Repeaters
   1. Where repeaters are required to connect two segments, repeaters shall be installed in an enclosure mounted in an accessible location.

2.4 BUILDING LEVEL CONTROLLERS (B-BC)
A. Building level DDC controllers shall be microprocessor-based, multi-tasking, multi-user, real-time digital control processors fully capable of being integrated with other BACnet building controllers or BACnet operator workstations.
B. Building level DDC controllers shall utilize BACnet open standard communication protocol. All Supervisory controllers shall communicate using BACnet/IP.
C. A BACnet Building Controller (B-BC) as defined by ASHRAE Annex L is a general purpose, field programmable device capable of carrying out a variety of building automation and control tasks. The BACnet Building Controller enables the specification of the following:
   1. Data Sharing
      a. Ability to provide the values of any of its BACnet objects.
      b. Ability to retrieve the values of BACnet objects from other devices.
      c. Ability to allow modifications such as scheduling and present value of some or all of its BACnet objects by another device.
2. Alarm and Event Management
   a. Generation of alarms / events notifications and the ability to direct them to recipients using
      the BACnet intrinsic or algorithmic alarming method.
   b. Maintain a list of unacknowledged alarms / events retrievable using standard BACnet
      Services.
   c. Maintain a list of alarms / events retrievable using standard BACnet Services.
   d. Notifying other recipients that the acknowledgment has been received.
   e. Adjustment of alarm / event parameters.
3. Scheduling
   a. Ability to schedule/modify weekly and exception schedule output actions, both in the local
      device and in other devices, both binary and analog, based on date and time.
4. Trending
   a. Collection and delivery of (time, value) pairs which includes a complete ‘BACnet trend log
      buffer upload’.
5. Device and Network Management
   a. Ability to respond to information about its status.
   b. Ability to respond to requests for information about any of its objects.
   c. Ability to respond to communication control messages.
   d. Ability to synchronize its internal clock upon request.
   e. Ability to perform re-initialize upon request.
   f. Ability to upload its configuration and allow it to be subsequently restored.
   g. Ability to command half routers to establish and terminate connections.

D. If Building Controllers have embedded I/O, all of the requirements for I/O that are described under
   Unit Level Controllers shall apply.
E. All ANSI/ASHRAE 135-2008 BACnet objects and object properties shall be supported so that
   alarms are sent from the Temperature Control Contractor's BACnet device without having to be
   solicited from any Hennepin County BACnet Operators Workstation (BOWS) or Web Server.
F. DDC panels and devices must utilize ANSI/ASHRAE 135-2008 BACnet Communications Protocol
   on a single building level network. BACnet communications must not cause derogated
   communications on the sites existing temperature control network including the site IP LAN.
   Derogation includes router, switch, or hub lockups, BACnet building controller lockups, excessive
   site network slowdowns, broadcast storms, unnecessary and repeated network broadcasts
   including BACnet 'who is', 'who has', I am, I have, and 'who is router' messages. Who is, I am
   messages should be limited to initially determine BACnet MAC addresses, segmentation support
   and maximum APDU length. Other reasons include when a device moves. BACnet MS/TP devices
   may not exceed 60 on a single BACnet MS/TP network.
G. All building level controllers shall have a local port that can connect to a laptop PC or other hand-
   held tool for local service work, troubleshooting, etc. Acceptable methods of connection are USB,
   Ethernet, and EIA-485.
H. Memory: Each DDC controller shall have sufficient memory to support its own operating system and
   databases including continuous trending on all analog points for that controller (AV, AI, AO) based on
   300 sample intervals.
I. Integrated On-line Diagnostics: Each DDC controller shall continuously perform self-diagnostics
   and communication diagnosis of all associated unit level equipment. The DDC controller shall
   provide both local and remote annunciation of any detected component failures, or repeated failure
   to establish communication. Indication of the diagnostic results shall be provided at each DDC
   controller and shall not require the connection of an auxiliary I/O device.
   1. The system is to report the alarm at the workstations and/or Web Server. In addition, the alarm
      will go to the building engineer, and building manager.
J. Power Fail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all DDC controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of
seventy-two (72) hours. Upon restoration of normal power, the DDC controller shall automatically resume full operation without manual intervention. Should a DDC controller memory be lost for any reason, the user shall have the capability of reloading the DDC controller via the local area network or via the local interface port.

K. System architectural design shall eliminate dependence upon any single device, front-end or higher level of controller for alarm reporting and control execution. Each DDC controller shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not majorly interrupt the execution of control strategies at other operational devices. All bound objects between controllers must maintain the last value or go to a pre specified default.

2.5 UNIT LEVEL CONTROLLERS

A. Each Unit Level DDC controller shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, input and output (DI, DO, AI, AO) capabilities. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification, the project drawings, and the point lists.

B. Unit level DDC controllers shall utilize BACnet/MSTP, BACnet arcnet or LON open standard communication protocol.

C. Power Fail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all DDC controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of seventy-two (72) hours. Upon restoration of normal power, the DDC controller shall automatically resume full operation without manual intervention. Should a DDC controller memory be lost for any reason, the user shall have the capability of reloading the DDC controller via the local area network or via the local interface port.

D. Each controller will be programmed such that each controlled device will have a default value in which to be commanded to in the event of a control sensor failure. The acceptable default values are, last command, full open, or full closed.

E. Controller I/O Requirements:

1. Analog Input Circuits:
   a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   b. For non-flow sensors, the control logic shall support a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
   d. For non-linear sensors such as thermistors and flow sensors the controller shall provide software support for the linearization of the input signal.

2. Binary Input Circuits
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.

3. Pulse Input Circuits
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 20 pulses per second.
4. True Analog Output Circuits
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliams or 0 to 20 milliams or to ranges within the full output range.
   b. The resolution of the D/A chip shall not be less than 0.04 Volts per increment or 0.08 milliamps per increment.
5. Binary Output Circuits
   a. Single pole, single throw or single pole, double throw relays.
   b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
6. Program Execution
   a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The sample rate for a process control loop shall be adjustable and shall support a maximum sample rate of 1 second.
   c. The sample rate for process variables shall be adjustable and shall support a maximum sample rate of 1 second.
   d. The sample rate for algorithm updates shall be adjustable and shall support a maximum sample rate of 1 second.
   e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

F. Unit level controllers shall not be dependent upon any other controller (unit or building level) to maintain safe operation of the controlled equipment.

G. All unit level controllers and/or enclosures shall be clearly labeled with their Node address. Tag all wiring on the DDC side of the interface panel identifying the associated point.

H. PROHIBITED: The combination of master/slave panels or point expansion for PID control loops without prior approval from Owner.

I. PROHIBITED: Splitting mechanical systems between more than one Unit Level controller without prior approval from Owner.

2.6 OPERATOR WORKSTATION (OWS)

A. The Operator Interface Workstations will comprise a Personal Computer (PC) together with operator terminals. The PC shall be a fully integrated node on the management level network and shall provide the operator with a graphical interface into the entire network. The monitoring and control functions of the BAS shall be totally independent of the PC such that if the PC is not operational there shall be no impact on the building control systems except for the reduced operator interface capability at that location.

B. On project where an OWS is specified, Hennepin County will furnish and install any required PC’s for the OWS at the project location. Contractor shall furnish and install all software and tools:

2.7 DDC SYSTEM SOFTWARE

A. Web-based BAS Server Software:
   1. Utilize the existing web based BAS server software for user access via industry standard web browsers. Contractor shall furnish controllers that are compatible with the current version of BAS server software.
   2. Contractor shall furnish and install a temporary server-workstation with BAS server software in the building until virtual server software is accessible on the Hennepin County network.
   3. Contractor shall provide all materials and labor required to connect to the BAS server software and to provide user access via industry standard web browsers which includes IE edge, Google Chrome and Firefox.
B. Software Upgrades
1. Contractor shall furnish and install the most current version of all BAS software available throughout the warranty period.
2. It is Hennepin County Facility Services desire to install the most current hardware and software available without jeopardizing control integration conformance or Hennepin County Standards.
   a. Contractor shall provide current BACnet Interoperability Building Blocks (BIBBs) and PICs Statements with a written request to approve new BTL Listed BACnet controllers or firmware revisions that are not currently preapproved and are not listed in Appendix A. Hennepin County will determine if the new controllers are acceptable for use on Hennepin County projects. Until such time that new controllers or firmware revisions are added to the preapproved controls list (Appendix A), they shall not be used on Hennepin County projects.

C. BACnet Operator Workstations (OWS)
1. Hardware Communication Function
   a. The OWS shall extract data from the hardware environment and move the data to the data server and/or present the data to the presentation system.
   b. The OWS shall extract data from the data server and present the data to the data presentation system.
   c. The OWS shall track operator actions at the presentation system and write a record of activities to the data server.
2. BACnet Compliance
   a. The OWS shall be able to initiate a "Who is" request to the network.
   b. The OWS shall respond to a "Who is" request from another BACnet device with an "I Am" response.
   c. The OWS shall be able to read binary and analog data from BACnet devices that support the reading of data.
   d. The OWS shall be able to write binary and analog data to BACnet devices that support the writing of data from a BACnet OWS.
   e. The OWS shall be able to receive alarm messages from BACnet devices that export alarm messages.
   f. The OWS shall be able to acknowledge alarms from BACnet devices.
   g. The OWS shall be able to edit time schedule parameters in BACnet devices that support the editing of time schedule parameters from a BACnet OWS.
   h. The OWS shall be able to retrieve a collection of trend samples from a BACnet device that stores the data and permits the export of that data to a BACnet OWS.
   i. The OWS shall be able to initiate time synchronization commands to all BACnet devices that support the receipt of time synchronization commands from a BACnet OWS.

2.8 CONTROL VALVES
A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic system globe valves shall have the following characteristics:
1. NPS 2 and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
   a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
4. Sizing: 4-psig maximum pressure drop at design flow rate or the following:
   b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

C. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.9 DAMPERS
A. Dampers: AMCA-rated, parallel-blade design for two-position control and opposed-blade design for proportional control applications; 0.108-inch minimum thick, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.064-inch thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze or nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 6 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.
B. Damper Actuators: Shall be analog, positive positioning, spring return. Motors shall be of the low voltage synchronous type and shall be non-overloading at a continuous stall. Actuators to be factory selected, mounted and tested for proper operation based on unit size, type and torque requirements.

2.10 CONTROL CABLE
A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section “Communications Horizontal Cabling.”

PART 3 EXECUTION
3.1 EXAMINATION
A. Verify that power supply is available to control units and operator workstation.

3.2 INSTALLATION
A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory trained electricians and mechanics qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company’s relationship with the manufacturer. Installation shall not be subcontracted. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative). The employees of the installing office shall be factory trained with training certification documentation provided in submittal package. All equipment shall be installed in strict accordance with manufacturer’s printed instructions.
B. Coordination and Access: Contractors shall coordinate with the work of other trades and allow access to all equipment per the manufacturer’s written instructions. All control devices requiring adjustment, calibration, reset, or having a readout display shall be located so as to be accessible from the equipment room floor or access platform without the use of a ladder. The Contractor shall remove and relocate inaccessible equipment and control devices as directed by the Owner or the Owner’s representative at no additional cost to the Owner. Contractor shall remove and relocate conduit and wiring, piping, and equipment, which restricts access to the work of other trades as directed by the Owner or the Owner’s representative at no additional cost to the Owner.

C. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

D. Connect and configure equipment and software to achieve sequence of operation specified.

E. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches above the floor. Thermostats or sensors mounted on outside walls shall be mounted on one-inch minimum thickness, rigid fiberglass insulating base (or equal).
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

F. Temperature Controls Contractor shall deliver all dampers and valves to Mechanical Contractors for installation in ducts and plenums. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Identify each item, mounted on the face of a control panel, with an engraved nameplate (1/4” high engraved letters minimum). Identify each item of control equipment (except room sensors and thermostats), inside control panels and on field mounted devices, with stamped tape, firmly attached to equipment (1/4” high letters minimum). Install labels and nameplates to identify control components according to Division 23 Section “Identification for HVAC Piping and Equipment.”

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section “Hydronic Piping.”

I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section “Refrigerant Piping.”

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

E. Contractor shall provide required 120 volt circuits and shall coordinate installation with the Electrical Contractor. Required field circuits shall be provided at no additional cost to the Owner.

F. Install raceways, boxes, and cabinets according to Division 26 Section “Raceway and Boxes for Electrical Systems.”

G. Install building wire and cable according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

H. Install signal and communication cable according to Division 27 Section “Communications Horizontal Cabling.”
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install concealed cable in raceway.
   4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
E. Connect hand-off auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   4. Test each system for compliance with sequence of operation.
   5. Test software and hardware interlocks.

C. Control System and DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check instrument tubing for proper fittings, slope, material, and support.
   5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
   6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
   7. Check temperature instruments and material and length of sensing elements.
   8. Check control valves. Verify that they are in correct direction.
   9. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
10. Check DDC system as follows:
    a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    b. Verify that spare I/O capacity has been provided.
    c. Verify that DDC controllers are protected from power supply surges.
11. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.8 ADJUSTING

A. Calibrating and Adjusting:
   1. After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as Work of this Section.
   2. Calibrate instruments and equipment using manufacturer’s written recommendations, procedures, and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   3. Provide diagnostic and test instruments for calibration and adjustment of system.
   4. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.9 HVAC TESTING AND BALANCING COORDINATION

A. Temperature Controls Contractor shall provide all necessary field labor to work with the project hydronic and ventilation Testing and Balancing Contractor. Temperature Controls Contractor shall provide assistance during testing and balancing to assure proper system calibration and capacities. Air handling unit DDC panels shall be retested and calibrated by Temperature Controls Contractor after balancing of fan, duct and coils is completed by the Balancing Contractor. All damper settings shall be reverified.
3.10 BUILDING AUTOMATION SYSTEM INSTALLATION
A. Installation and Supervision: The installation and supervision of this project shall be carried out by factory trained personnel who are employed by the Contractor and licensed for this type of work.
B. Application Software Documentation: Contractor shall provide an AutoCAD blueprint documentation of the software application program for each DDC panel. Documentation provided shall include block software flowcharts, showing the interconnection between each of the control algorithms and sequences of operation. For systems utilizing program listings, a program listing shall be printed onto the same blueprint, along with the program flowchart, and description of the sequence of operation. This blueprint shall be stored and maintained in each panel. System acceptance shall not be completed until this documentation is provided and located in each panel.
C. Acceptance Testing: Point Verification: To verify end-to-end operation of the system, the Contractor shall provide a hard copy of an All Points Summary Listing to the Owner of each part or system to be placed in warranty by the Owner.
D. Sequence Verification: The Contractor shall notify the Owner’s representative of systems which perform all specified sequences. The engineer shall verify all sequences of operation and place the system into warranty acceptance test.

3.11 NETWORK COMMUNICATION TRUNK AND TERMINATIONS
A. A backbone communication tie in point will be provided and installed by Hennepin County IT. The Temperature Controls Contractor is responsible for all DDC network wiring within the building.
B. The Temperature Controls Contractor shall provide a network riser for all locations as part of construction, submittals and as-built documents. All fiber and network devices shall be clearly marked.

3.12 IP INTERFACE DEVICES
A. Install Building Controllers for each required connection to the dedicated DDC IP network.
B. The Building Controllers shall be configured and commissioned to ensure that the only data traffic on the IP is data that is essential for operation of the system.

3.13 SYSTEMS INTEGRATION
A. The Temperature Controls Contractor shall be fully responsible for the installation and commissioning of the integrated system.
B. Temperature Controls Contractor shall be responsible for all on-site and off-site programming as required to provide a fully operational integrated system. Contractor shall coordinate all programming and point mapping requirements with Hennepin County Property Services. If the Contractor deems changes to the Contract Documents necessary, submit details in writing, to the Owner for approval.
C. The Temperature Controls Contractor shall provide all engineering and analysis work necessary to determine the method of network connectivity. The Contractor shall furnish, install and program hardware, wiring, network devices, cabling, software and graphics to connect the new DDC controls system to Hennepin County network.

3.14 BUILDING SYSTEMS AUTOMATION NETWORK PERFORMANCE REQUIREMENTS
A. The Temperature Controls Contractor will supply all hardware software labor, material and expertise necessary to tie the BACnet building controller(s) to Hennepin County network. BACnet integration must conform to Data Link Layer Option BACnet/IP shown in BACnet ANSI/ASHRAE 135-2008 publication Annex J.
B. All BACnet read property requests from any BACnet Operator Workstation must not take more than 20 ms to process once the BACnet Building Controller receives the read request. Object properties that are read requested that require multiple segmented packets must not take more than 50 ms to...
process the request. All information that is received from a read property multiple or single read property must not be older than 10 seconds.

3.15 BUILDING ALARMS AND CRITICAL SYSTEM MONITORING
A. The control specifications and/or point lists shall identify building alarm requirements.
B. The Temperature Control Contractor shall provide an alarm matrix with the Control Submittal that lists all building alarm points. The matrix shall identify an alarm class for each alarm point. Alarm Classes shall include:
   1. Critical Alarms: Refer to Appendix B.
   2. Page/Text Alarms: Building alarms that need immediate attention, but are not critical. Alarm notification to the Building Engineer by page, text or by a means of communication defined by the Building Manager.
   3. General Alarms: All building alarms. Alarm notification to BAS.
C. The Temperature Control Contractor shall use the Hennepin County Critical Alarm Standard in Appendix B as a guide for defining critical alarms.
D. The Hennepin County Building Manager, Building Engineer and Automation Technician shall review the building alarm matrix and make corrections as needed. The Approved Alarm Matrix will be returned to the Temperature Control Contractor and shall be used for programming building alarms.
E. The Temperature Control Contractor shall follow the BACnet Alarm Recipient Standard in Appendix D.
F. In facilities where critical system monitoring is performed by DDC equipment, the controls contractor shall be responsible for all required material and labor to connect the Owner’s critical equipment to the DDC system.
G. In buildings with emergency generators, all DDC devices and networking equipment that monitor and/or transmit critical system monitoring points shall be connected to emergency power.
H. The controls contractor shall provide UPS power supplies for all DDC and networking devices that monitor and/or transmit critical system monitoring points. UPS shall be capable of maintaining full operation for a period no less than 4 hours.
I. The DDC system shall monitor all UPS required under this section and report an alarm to SOC whenever the UPS senses a loss of primary power or indicates a fault of any kind.

3.16 POINT NAMING/POINT LOGICAL GROUPING AND GRAPHICS
A. The programmer shall meet with Hennepin County Facility Services before proceeding with programming to review point naming, system layout, point logical grouping, graphics, graphical display response time, and tree structure. The controls contractor shall contact Hennepin Facility Services before deviating from Hennepin County Standards. Failure to work within Hennepin County Standards may result in the Contractor being required to redo their work without compensation.
B. Supervisory controllers must be named with their corresponding building number & panel number. Before database generation is started, controls contractors are advised to contact Hennepin County for questions regarding naming. Hennepin County reserves the right to require changes to point naming if the controls contractor does not clarify naming before start of the controller database(s).
C. BACnet Object Identification numbers must also include building number and panel number. Controls contractors must coordinate Device IDs & IP address information with Hennepin County prior to the start of database generation.
D. The Temperature Control Contractor shall follow the BACnet Device and Network Number Standards in Appendix C for all Hennepin County controls projects.
3.17 PROGRAMMING METHODS USING THE GRAPHIC INTERFACE

A. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to other objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

B. Configuration of each object will be done through the object’s property sheet using fill-in-the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

C. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When Off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

D. Control system logic shall be viewable in real time from the Web Browser. Linking real time control system logic from the server to the Web Browser in a “view only” mode is acceptable.

E. Control PID’s shall be accessible in real time for tuning and diagnosing from the Web Browser. Exposing adjustable PID’s in Web Browser graphics is acceptable.

F. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

G. The system shall support object duplication within a customer’s database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

H. The O&M Documents and sequence of operation shall be viewable from the control system.

3.18 CRITICAL ALARM COMMISSIONING

A. Complete the Critical Alarm Commissioning Checklist defined in Appendix E and include it with close-out documentation.

B. Schedule a critical alarm commissioning test with the Owner to test critical BACnet intrinsic and algorithmic alarms going to the Hennepin County Security Operations Center (SOC) BACnet to ANSI/SIA DC-09-2013: Security Industry Association Manitou Interface. The Control Contractor shall test each critical BACnet alarm to confirm that they are properly transmitted to the SOC interface as outlined in the control and integration specification.

3.19 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section “Demonstration and Training.”

B. Temperature Controls Contractor shall provide system training for Hennepin County operation personnel. Training shall include on-site class time as well as field hands-on system training, and shall include on site walk-through and hands-on operation of all project control equipment.

3.20 COMMISSIONING

A. Temperature controls contactor shall perform services and activities to participate in the commissioning. Provide web-based access to the commissioning agent as required to facilitate commissioning. Fill out forms and provide information as required to participate in the project commissioning. This may include operation of ventilation systems, valves, and other equipment as directed by and in the presence of the Commissioning Agent. Commissioning Agent shall review the performance reports, forms, and controls submitted by the temperature controls contactor.
temperature controls contactor shall work with the Commissioning Agent to rectify issues identified in the reports and in the project commissioning.

B. Complete the commissioning checklist defined in Appendix F. The Commissioning Agent in coordination with the Controls Contractor shall complete and sign off on all checklist tasks prior to the start of system warranty. The Commissioning Agent and Controls Contractor shall arrange a review meeting with the Owner to demonstrate that all of the commissioning checklist tasks have been completed to the satisfaction of the Owner. The completed commissioning checklist form containing sign-off from all parties shall be included in the close-out documentation submitted by the Contractor.

END OF SECTION
## APPENDIX A – HENNEPIN COUNTY PREQUALIFIED CONTROLS

List Updated 03/01/2017

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<tr>
<td>Johnson Controls</td>
<td>Field</td>
<td>TEC3320-00-000</td>
<td></td>
</tr>
</tbody>
</table>
New Control Devices:

Minor revision changes or build number updates to controllers from the approved devices listed above are acceptable.

The BTL listing mark must be present on all supervisory controllers and BACnet MS/TP sub controllers.

End of Appendix A
APPENDIX B – HENNEPIN COUNTY CRITICAL ALARM STANDARD

The intent of this list is to provide a guide for those types of facility alarms considered “critical” which can be communicated to the Security Operations Center via the BAS network. The total number of alarm points transmitted should be limited to only those that are necessary to protect the facility from damage. Multiple alarm points that indicate the same potential condition should be avoided.

Proper instructions for the SOC Operator should be given and the instructions checked annually for accuracy. Other operational failure alarms can be transmitted via phone text message, email, or other sources of notification to the proper staff.

FIRE ALARMS
- Fire alarms received by the BAS can be transmitted to SOC, but are to be considered as redundant alarms. The BAS should not be the primary transmission method for fire alarms.

ALARM TEST
- A routinely scheduled test of the BAS communications network, that ensures alarms are being received by SOC, should be programmed

BOILER FAILURE / LOW HEATING WATER SUPPLY TEMPERATURE / HOT WATER CIRC PUMP FAIL
- The proper alarm(s) should be used to alert SOC that the facility’s main heating system (or component) has or is failing. Limit the number of alarms while making sure your facility is protected.

LOSS OF POWER / EMERGENCY GENERATOR
- An alarm to indicate a facility power failure, generator running, or generator under load. Make sure the alarm instructions indicate the actual condition. This alarm can sometimes be wired so that the discontinuation/restoration of the alarm point indicates a restoration of normal power.

LOW SPACE TEMPERATURE
- This alarm should be used to protect an area vulnerable to low temperature damage. It can be physically located in an area known to be first to cool down during a heating failure, being a supplement to the boiler/heating failure alarm above.

AIR HANDLING UNIT FAIL OR LOW TEMP/FREEZE ALARM
- The proper alarm(s) can be used to alert SOC that an air handling unit (or component) critical to the safety of the facility has or is failing. Limit the number of alarm points while making sure your facility is protected.

EXHAUST FAN FAIL
- The proper alarm(s) can be used to alert SOC that an exhaust unit (or component) critical to the safety of the facility has or is failing. Limit the number of alarm points while making sure your facility is protected. Extra thought should be given as to whether this situation is critical to the facility.

OTHERS
- Other alarms that do not fall into these categories may be needed to protect certain facilities. It is the responsibility of each Building Operations Manager to make sure that the necessary alarm points are transmitted, and to be able to justify the need. It is our intent to limit the alarm activity transmitted to SOC to those alarms that are truly critical.

End of Appendix B
BACnet Device and Network Number Standards
All point names must start with the building number. The point name should also include a reference to the system the point is associated with. Defined by Hennepin County.

BACnet Device Assignment Range 0-4194302 Hennepin County Standard BACnet device assignment
Digits 1,234,567
X,XXX,XXX
1st digit should normally be 1

2nd, 3rd, and 4th digit will equal the building number. In the case where the building number repeats itself with a letter or decimal such as 18 and 18n or 18.1 then the 1st digit (which is normally 1) can be changed to 2 or 3 to differentiate between buildings with the same number. The first digit can only be 1, 2 or 3. Do not use 4.

5th 6th and 7th digit will be assigned as follows:
1,XXX,001 to 1,XXX,099 reserved for building supervisory controllers or BACnet routers. These 3 digits should be sequentially assigned starting from the lowest level in the building to the highest level. Floors with multiple supervisory controllers or routers can be assigned by the temperature control contractors own discretion.

BACnet Field level device (MAC) assignment: 5th 6th and 7th digit will be assigned as follows:
X,XXX,100 to X,XXX,999 reserved for SubLAN devices such as VAV controllers. Can be assigned by the temperature control contractors own discretion. Hennepin County suggests the 5th digit correspond with the building floor number.

Temperature Control Contractor shall set Max Master in each MS/TP Device. Do not leave the default setting (typically 127). This setting defines the address that is searched for on a BACnet LAN (last address). Each search involves sending a message and waiting for a response or a timeout (if the devices are not there). Hennepin County restricts the maximum number of BACnet subLAN devices on each loop to 60 or less.

Device packing practice must be followed. All SubLAN devices must be “packed” so there are no unused addresses between devices.

BACnet Network Number Range 0 to 65,535
Hennepin County Standard BACnet network number assignment Digits 12,345
XX,XXX
1st and 2nd digit will range from 11 to 64. Each SubLAN must be assigned to a unique number. All Supervisory controllers that are not BACnet routers or do not originate a BACnet subLAN shall be assigned to 10 in the 1st and 2nd digit.

3rd, 4thand 5th digits will be set to the building number. In cases where the building number repeats it’s self with a letter or decimal such as 18 and 18n or 18.1 than Hennepin county contracting coordinator will coordinate and assign these 3 digits.

BACnet User Datagram Protocol (UDP) port assignment must always be set to a UDP that is issued by the Owner. All BACnet IP devices must be set to that UDP. The supervisory controller must act as a BBMD accepting foreign device registrations. The number of simultaneously foreign device registrations will be set to 10.

End of Appendix C
APPENDIX D – BACnet ALARM RECIPIENT AND COMMAND PRIORITY STANDARDS

All BACnet alarms shall be directed to the Hennepin County primary SOC BACnet alarm receiver via notification class object 01-03. The BACnet Notification object is a BACnet Object that is used to send event notifications within a BACnet System. BACnet notification class object 01 shall be used for the highest priority alarms such as building freeze stat alarms, loss of control air, loss main heating system, sump pump failures etc. Priority alarms shall be determined by Hennepin County Facility Services (see “Appendix B” for details). Notification class object 02 shall be used for medium priority alarms that will be called out to the building engineer, but only requires a message be left with the building engineer. Notification class object 03 is for all priority alarms that will not be sent to the Hennepin County’s SOC BACnet alarm receiver. This alarm shall be sent to the building engineer’s web station or laptop/desktop client.

Notification object 01 and 02 shall contain device recipient 1000 (SOC alarm receiver). This recipient shall be setup for confirmed alarm transmission, handling type alarm, all days and times 24/7/365. Notification object 03 shall contain device recipient 1001 (building engineer alarm receiver). This recipient shall be setup for unconfirmed alarm transmission, handling type alarm, all days and times 24/7/365.

All intrinsic alarm and event enrollment object names that are to be sent to Device 1000 (SOC Interface) must contain the prefix “SOC”.

BACnet alarm priorities for notification class 01 (Critical Priority SOC calls out immediately):  To: Off Normal Priority 50 To: Fault Priority 100 To: Normal Priority 150

BACnet alarm priorities for notification class 02 (High Priority Leave Message): To: Off Normal Priority 50 To: Fault Priority 100 To: Normal Priority 150

BACnet alarm priorities notification class 03 (To building engineer only): To: Off Normal Priority 50 To: Fault Priority 100 To: Normal Priority 150

BACnet Device Command Priorities Standards

BACnet Command Priority
1 Manual Life-Safety
2 Automatic Life-Safety
3 Available
4 Available
5 Critical Equipment Control
6 Minimum On/Off
7 Available
8 Manual Operator Override

End of Appendix D
APPENDIX E – CRITICAL ALARM COMMISSIONING TEST

The Owner or Owners Representative must complete and sign off on the critical alarm test before the control system warranty period can start. The test is not intended to replace the Contractor's normal and accepted procedures for installing and pre-testing equipment or relieve the Contractor of standard checkout and start-up responsibilities, but to verify that critical alarms properly transmit to the SOC interface.

General:

Temperature Control Contractor must expose points as BACnet alarms (intrinsic or algorithmic) and assign them to BACnet device 1000 (SOC interface)

Expose all existing alarming points to BACnet/IP on the Hennepin County LAN at subnet and UDP agreed on by Owner. Build notifications classes as described below and assign one recipient (SOC BACnet alarm translator) at device address 1000. Assign and setup point objects as required.

A complete list of Intrinsic and algorithmic alarms showing the supervisory controllers BACnet UDP port and all object instance numbers must submitted to the Owner in a PDF format 5 days before test is conducted.

The BACnet Building Controller that is located in every building must send a properly formatted BACnet intrinsic or event enrollment alarm message (not COV) to the SOC BACnet to SIA translator. The BACnet alarm (not event) message must include the BACnet destination object ID of 1000, process ID of 3 (set by BACnet to SIA translator), and a confirmed notification message type. Set points assigned to SOC Notification class event enable To Off Normal, To Fault, To Normal

The temperature controls contractor shall setup alarms in each building based on Hennepin County Alarming Standards as intrinsic or event enrollment. The "base load" of critical alarms should be configured with intrinsic reporting. The remaining complex situations should be configured using algorithmic reporting by creating individual event enrollment objects for each alarm. Hennepin County will use the algorithmic reporting method when necessary to reduce the number of false alarms, specifically during normal equipment cycles and floating set point changes. The Controls Contractor shall make every effort to eliminate false alarms during 'normal' periods.

Notification Class Test: Ensure each previously agreed upon alarm object is assigned to the newly created 'Critical Points To SOC' notification class.

☐ Notification class object (alarm handlers) on all controllers transmitting alarms to SOC have been created
☐ Object name and/or descriptor of notification class object is set to 'Critical Points To SOC'
☐ Notification class is assigned to instance number 01. If already used on existing, indicate notification class number.
☐ Notification recipient 1000 (SOC Alarm Receiver) is present in the recipient list using Object ID entry method
☐ Recipient process ID has been set to 3
☐ Time and day is setup to transmit alarms to device 1000 for all dates and all times
☐ All 3 transition notifications are turned on. To Off Normal, To Fault, To Normal.
☐ Notification messages are set to 'Confirmed'
☐ All alarm priorities are set to 'Off Normal 50', 'Fault 100', 'Normal 150'
☐ Alarm type is set to 'Alarm' and not 'Event'
☐ Each agreed upon alarm object is assigned to the newly created 'Critical Points To SOC' notification class object

Hennepin County
North Regional Library Refurbishment

Control Standard for BACNet Integration
Network Settings:

BACnet User Datagram Protocol (UDP) port assignment is set to the agreed upon UDP port for all BACnet devices. Enter UDP port number here.

Hennepin County BACnet Device Number Standards Setup for New Installations:

BACnet Device Assignment Range 0-4194302 Hennepin County Standard BACnet device assignment Digits 1,234,567
Ensure the 1st digit is a 1
Ensure 2nd, 3rd, and 4th digit is the building number. In the case where the building number repeats itself with a letter or decimal such as 18 and 18n or 18.1 then the 1st digit (which is normally 1) can be changed to 2 or 3 to differentiate between buildings with the same number.

Ensure the 5th 6th and 7th digit is assigned as follows:
1,XXX,001 to 1,XXX,099 reserved for building supervisory controllers or BACnet routers. These 3 digits should be sequentially assigned starting from the lowest level in the building to the highest level. Floors with multiple supervisory controllers or routers can be assigned by the temperature control contractors own discretion.

Ensure that BACnet Field level device (MAC) assignment: 5th 6th and 7th digit is assigned as follows:
X,XXX,100 to X,XXX,999 reserved for SubLAN devices such as VAV controllers. Can be assigned by the temperature control contractors own discretion. Hennepin County suggests the 5th digit correspond with the building floor number if possible.

BBMD Test Support:

One supervisory controller on each separate Hennepin County subnet is enabled with foreign device registration and setup for 10 users. The SOC interface will register to this. Contractor shall send IP address of BBMD that will allow foreign device registration and any other detailed information to Owner 5 days before test. IP Address of BBMD__________.

Hennepin County
North Regional Library Refurbishment

Control Standard for BACNet Integration
Alarm and Event Services Test:

All alarms must be properly formatted and sent to SOC interface and observed by Owner in real time during SOC interface critical alarm test.

Each alarm object type listed below displays the alarm to the SOC interface as follows: Present_Value changes to a new state for longer than Time_Delay AND the new transition is enabled in Event_Enable an intrinsic alarm shall be sent to the SOC interface for the following standard BACnet objects:

- All Binary Inputs if applicable successfully received at alarm region of SOC interface
- All Binary Values if applicable successfully received at alarm region of SOC interface
- All Multi-state Inputs if applicable successfully received at alarm region of SOC interface
- All Multi-values Inputs if applicable successfully received at alarm region of SOC interface

### BI, BV, MSI, MSV Intrinsic Alarm Test

<table>
<thead>
<tr>
<th>Pass:</th>
<th>Fail:</th>
<th>Notes / Exceptions:</th>
</tr>
</thead>
</table>

Each alarm object type listed below displays the alarm on the SOC interface as follows: Present_Value exceeds range between High_Limit and Low_Limit for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable. An intrinsic alarm shall be sent to the SOC interface for the following standard BACnet objects:

- All Analog Inputs if applicable successfully received at alarm region of SOC interface
- All Analog Outputs if applicable successfully received at alarm region of SOC interface
- All Analog Values if applicable successfully received at alarm region of SOC interface

### AI, AO, AV Intrinsic Alarm Test

<table>
<thead>
<tr>
<th>Pass:</th>
<th>Fail:</th>
<th>Notes / Exceptions:</th>
</tr>
</thead>
</table>

Each alarm object type listed below displays the normal to the SOC interface as follows: If Present_Value returns within the High_Limit - Deadband to Low_Limit + Deadband range for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable. An intrinsic return to normal shall be sent to the SOC interface for the following standard BACnet objects:

- All Analog Inputs if applicable successfully received a return to normal at alarm region of SOC interface
- All Analog Outputs if applicable successfully received a return to normal at alarm region of SOC interface
- All Analog Values if applicable successfully received a return to normal at alarm region of SOC interface

### AI, AO, AV Intrinsic Normal Test

<table>
<thead>
<tr>
<th>Pass:</th>
<th>Fail:</th>
<th>Notes / Exceptions:</th>
</tr>
</thead>
</table>

Each alarm object type listed below displays the normal to the SOC interface as follows: If Present_Value differs from Feedback_Value for longer than Time_Delay AND the new transition is enabled in Event_Enable an intrinsic alarm shall be sent to the SOC interface for the following standard BACnet objects:
All Binary Outputs if applicable successfully received a return to normal at alarm region of SOC interface

All Multistate Outputs if applicable successfully received a return to normal at alarm region of SOC interface

<table>
<thead>
<tr>
<th>BO, MSO Intrinsic Alarm Test</th>
<th>Pass:</th>
<th>Fail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes / Exceptions:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Algorithmic Alarm Test:

Change of state:

Each event enrollment change of state type displays the alarm to the SOC interface as follows: If Present_Value changes to a new state for longer that Time_Delay AND the new transition is enabled in Event_Enable. An algorithmic alarm shall be sent to the SOC interface alarm region

<table>
<thead>
<tr>
<th>Algorithmic COS</th>
<th>Pass:</th>
<th>Fail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes / Exceptions:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Command failure:

Each event enrollment command failure type displays the alarm to the SOC interface as follows: If Present_Value differs from Feedback_Value for longer than Time_Delay AND the new transition is enabled in Event_Enable. An algorithmic alarm shall be sent to the SOC interface alarm region

<table>
<thead>
<tr>
<th>Algorithmic Command Failure</th>
<th>Pass:</th>
<th>Fail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes / Exceptions:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Floating limit:

Each event enrollment floating limit type displays the alarm to the SOC interface as follows: If Setpoint_reference returns or leaves from within the High_Differential_Limit or Low_Differential_Limit - Deadband to High Differential Limit or Low Differential Limit + Deadband range for longer than Time_Delay

AND the new transition is enabled in Event_Enable and Limit_Enable. An algorithmic alarm or return to normal shall be sent to the SOC interface alarm region

<table>
<thead>
<tr>
<th>Algorithmic Floating Limit</th>
<th>Pass:</th>
<th>Fail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes / Exceptions:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Out of range

Each event enrollment out of range type displays the alarm to the SOC interface as follows: If Present_Value returns or leaves from within the High_LIMIT or Low_LIMIT - Deadband to High_LIMIT or Low_LIMIT + Deadband range for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable. An algorithmic alarm or return to normal shall be sent to the SOC interface alarm region

<table>
<thead>
<tr>
<th>Algorithmic Out of Range</th>
<th>Pass:</th>
<th>Fail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes / Exceptions:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Alarm Services Test:
Owner shall restart SOC interface and run alarm summary service after alarm is sent.

<table>
<thead>
<tr>
<th></th>
<th>Pass:</th>
<th>Fail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get Event Info.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>协调和执行测试</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get Alarm Summary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>协调和执行测试</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alarm Services Test</th>
<th>Pass:</th>
<th>Fail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes / Exceptions:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

End of Appendix E
APPENDIX F – COMMISSIONING CHECKLIST

The Commissioning Agent in coordination with the Controls Contractor shall complete and sign off on all checklist tasks prior to the start of control system warranty. In addition, the Commissioning Agent and Controls Contractor shall arrange a review meeting with the Owner, after all the checklist tasks are completed, to demonstrate that all of the commissioning checklist tasks are done to the satisfaction of the Owner.

COMMISSIONING CHECKLIST FOR CONTROLS

<table>
<thead>
<tr>
<th>Task #</th>
<th>Description of Task</th>
<th>Cx Agent Sign-Off Initials</th>
<th>Control Contractor Sign-Off Initials</th>
<th>Owner Sign-Off Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>O&amp;M Documents have been submitted to the Owner and are complete and accurate.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The Sequence of Operation is complete and accurate.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>The O&amp;M Documents and Sequence of Operation are viewable from the control system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>As-Built Drawings have been submitted to the Owner and are complete and accurate.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>The As-Built Drawings show all devices and wiring.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>All adjustable points are displayed on the graphics.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>All adjustable points have been tested and function per design.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Control system &quot;As-Built&quot; drawings and the sequence of operation can be accessed by link on the control system graphics page.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>The control logic is viewable in real time from the Web Browser. Linking real time control logic from the server to the Web Browser in a &quot;view only&quot; format is acceptable.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>The control PID’s are accessible to the user to set values for tuning PID’s and diagnosing logic execution without needing Administrative rights. Exposing adjustable PID’s in Web Browser graphics is acceptable.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Control system software and tools have been furnished.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Final Test &amp; Balance report has been provided (if TAB is subcontractor to Controls Contractor)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Control system training per specifications has been provided.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Control system software and tools have been furnished.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

End of Appendix F
Hennepin County requires HTML5 web browser access to all Hennepin County Building Automation Systems (BAS). Web Access as defined in this Appendix must be accomplished using standard web browsers utilizing HTML5 without the additions of any web browser add-ons, extension or plugins. HTML5 is the latest "standardized" implementation of HTML, CSS, and JavaScript. Hennepin County shall utilize Chrome, Firefox or IE edge web browsers for DDC installations. This same level of access must be available using smart devices, tablets and iPads. The Web Browser user interface shall (as a minimum) provide navigation, and display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events and schedules. Hennepin County requires access to DDC systems based on the minimum requirements shown below and requires the ability to navigate through the system using a web browser to accomplish these requirements.

1. Data Sharing Between Controllers and Web Client
   a. Ability to read all required properties of BACnet objects as defined in Appendix G.
   b. Ability to modify BACnet properties as defined in Appendix G. All objects listed as writable in Appendix G must also be writable using Web Client.
   c. The ability to control binary, analog and multistate (if existing) present values via Web Client.
   d. The ability to read and write to all properties including setpoint adjustments as defined in Appendix G based on BACnet 2008 standard (or newer).

2. Alarm and Event Management
   a. Ability to receive and process alarms via Web Client.
   b. Retrieve a list of unacknowledged alarms / events to a standard web report.
   c. Retrieve a list of alarms / events retrievable using a standard web report.
   d. Notify other BACnet recipients that the acknowledgment has been performed.
   e. Perform adjustment of alarm / event parameters.

3. Scheduling
   a. Ability for Web Client to schedule/modify weekly and exception schedule output actions, both in the local device and in other devices based on controller date and time. Ability to read and write schedule properties as defined in Appendix G.

4. Trending
   a. Use Web Client to setup the collection of (time, value) pairs which includes a complete ‘trend log buffer upload’ using standard BACnet trend harvesting techniques.
   b. Ability to display and print trend information from Web Client using ‘trend log buffer’ with the ability to display trend data in both text and graphical format.
   c. Long term harvested trends must be accessible for text and graphical display from Web Client. This data is typically present at the vendor’s server and not a supervisory controllers.

5. Graphic Display
   a. Ensure that vendor developed Web Client based graphics can be displayed ‘as is’ on web server or displayed with no loss of usage after a graphic conversion has been applied. All graphics that have been developed for vendor’s thick client must be hostable without having to rebuild or redesign graphical screens in order to host and access them from a thin client Web Client. Graphics must also be accessible from Smart Devices, Tablets and iPads browsers.
   b. Navigation through the Web Client GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control), and/or by selecting dynamic links to other system graphics. Both the navigation tree and graphics screen shall be displayed simultaneously, enabling the operator to select a specific system or equipment, and view the corresponding graphic. The navigation tree if present must show a physical tree layout based on individual panel configurations and a custom tree layout typically based on fans, rooms, cooling and heating systems etc.

6. User Configuration
   a. Web Client must have the ability to create and modify users for system access.
Standard Object Types Supported:

Owner requires support for the following Standard ANSI/ASHRAE 135-2008 (or newer). BACnet objects to be exposed using web services and accessible using HTML5 based browser as described in the beginning of this Appendix. See the Object tables below for Individual Object Property requirements.

<table>
<thead>
<tr>
<th>BACnet Object Type to be exposed as web Service</th>
<th>Hennepin County Requirement for each object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Input</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Analog Output</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Analog Value</td>
<td>Vendor required to support object if object is used</td>
</tr>
<tr>
<td>Binary Input</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Binary Output</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Binary Value</td>
<td>Vendor required to support object if object is used</td>
</tr>
<tr>
<td>Calendar</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Device</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Event Enrollment</td>
<td>Vendor required to support object if intrinsic alarming is not supported</td>
</tr>
<tr>
<td>Multistate Input</td>
<td>Vendor required to support object if object is used</td>
</tr>
<tr>
<td>Multistate Output</td>
<td>Vendor required to support object if object is used</td>
</tr>
<tr>
<td>Multistate Value</td>
<td>Vendor required to support object if object is used</td>
</tr>
<tr>
<td>Notification Class</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Schedule</td>
<td>Vendor required to support object</td>
</tr>
<tr>
<td>Trend Log</td>
<td>Vendor required to support object</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analog Input Property Identifier</th>
<th>Web Browser Access Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Identifier</td>
<td>Readable</td>
</tr>
<tr>
<td>Object Name</td>
<td>Readable</td>
</tr>
<tr>
<td>Object Type</td>
<td>Readable</td>
</tr>
<tr>
<td>Present Value</td>
<td>Readable</td>
</tr>
<tr>
<td>Status Flags</td>
<td>Readable</td>
</tr>
<tr>
<td>Event State</td>
<td>Readable</td>
</tr>
<tr>
<td>Out Of Service</td>
<td>Readable</td>
</tr>
<tr>
<td>Units</td>
<td>Readable</td>
</tr>
<tr>
<td>Time Delay</td>
<td>Readable-1</td>
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Multi-state Input object not required by Hennepin County to be exposed as a web services object if not present in controller.

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1. This property shall be required if Fault Values is present.
2. These properties are required if the object supports intrinsic reporting.
Multi-state Output object not required by Hennepin County to be exposed as a web services object if not present in controller.

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Multi-state Value object not required by Hennepin County to be exposed as a BACnet object if not present in controller.

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1 These properties are required if the object supports intrinsic reporting.
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1- Writable indicates a requirement of Hennepin County which is over and above BACnet conformance requirements for 2008.

### Schedule Property Identifier

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1. These properties are required if the object supports intrinsic reporting.
2. These properties are required if the object supports clock-aligned logging.

End of Appendix G
SECTION 23 09 93
SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes sample control sequences for HVAC and plumbing systems, subsystems, and
      equipment on Hennepin County projects. Provide other control sequences as necessary to
      suite the specific project’s needs.
      1. Temperature and pressure set points listed shall be adjustable.
      2. Provide the building automation system operator with manual over-ride for automatic control
         valves and dampers. The over-ride shall allow the operator to command open or close valves
         and dampers.
   B. Related Sections include the following:
      1. Division 23 Sections "Instrumentation and Control for HVAC" for control equipment and devices
         and for submittal requirements,” and “Data and Control Points List.”

1.3 DEFINITIONS
   A. Air terminal damper open: The damper will open to the scheduled maximum airflow.
   B. Damper or valve full open: Damper or valve will be 100 percent open.
   C. DDC: Direct digital control.
   D. Modulate: Proportionally position.
   E. Set points: Set points will be operator adjustable unless noted as fixed.
   F. Temperature: Air and liquid temperatures are in degrees F.
   G. VAV: Variable air volume.

1.4 TIME SCHEDULE
   A. HVAC and designated plumbing equipment will be scheduled for occupied and unoccupied
      status.
   B. The daily scheduler will allow the system operator to switch between occupied and unoccupied
      status a minimum of five times per day. Holidays and weekends will be scheduled separately.
   C. The initial schedule will incorporate HVAC and designated plumbing equipment. Coordinate the
      initial scheduled occupied/unoccupied hours with the owner and incorporate the schedules before
      substantial completion.
   D. Air Handling Units Systems Control Sequence (AHU-1 through, AHU-5)
      (Variable Volume Units with Hot Water Heating, and DX Cooling)
      1. Control of supply fans shall be programmed through local DDC air handling unit DDC controller
         and central computer control panel.
      2. Warm-Up Mode (Ambient Outdoor Air Temperature Below 60 degrees F, adjustable): When air
         handling unit starts through local DDC controller or central computer station, supply fan shall
         start after end switches verify return, air intake positioning. A warm-up cycle shall commence,
         opening return air damper to 100% position, and closing air intake and exhaust dampers.
Warm-up sequence shall modulate the heating valve to maximum supply air heating setpoint of 95 degrees F (adjustable), and provide 100% return air until warm-up setpoint (70 degrees F, adjustable) return air is reached. Then the supply fan system shall operate in normal occupied mode.

3. In Winter, unoccupied mode only (ambient outdoor air temperature below 40 degrees F, adjustable), respective fan systems shall cycle as required, with preheat coil activated, to satisfy a key space thermostat/sensor in one perimeter space for each air handling unit zone. Winter unoccupied heating sequence shall be same as warm-up mode.

4. During normal occupied mode, fan shall run continuously. Static pressure sensors located 2/3 distance along each main duct run shall, through local DDC controller and central computer, send a signal to variable speed drive on supply fan and vary the fan speed to satisfy most demanding main duct pressure required. Airflow for supply fan shall be monitored through supply airflow measuring stations.

5. High and low static pressure safety sensors and devices shall stop the respective fan. Sensors shall be interconnected to respective DDC control panels. Static sensors shall be set at 20% (adjustable) above the external static pressure values indicated on the Air Handling Unit on the drawings.

6. Discharge air temperature control (Summer with outside air temperature above 50 degrees F and condensing unit operating): If the discharge air temperature rises above the discharge air setpoint (55 degrees F, adjustable), the condensing unit shall operate to maintain 55 degrees F (adjustable) discharge air temperature subject to a discharge air low limit (45 degrees F, adjustable). Outside air intake dampers, return air dampers and relief dampers shall modulate same as in economizer mode to attain minimum mixed air temperature. When outside air temperature rises above return air temperatures, air intake damper and relief dampers shall modulate to minimum position. Return air damper shall modulate to maximum setting.

7. Discharge air temperature control (Winter with boiler operating): If the discharge air temperature drops below the discharge air setpoint of 55 degrees F (adjustable), normally open to the coil electric actuated 2-way hot water control valve shall modulate water flow to maintain 60 degrees F (adjustable) discharge air temperature. Air intake damper, return air damper and exhaust damper shall modulate same as economizer mode to attain maximum mixed air temperature. When mixed air temperature drops below 40 degrees F (adjustable), air intake dampers and exhaust dampers shall modulate to minimum position. Return air damper shall modulate to maximum setting.

8. Economizer Control: The outside air, return air, and relief air dampers shall modulate to maintain 55 degrees F (adjustable) discharge temperature until minimum outside air damper setting is reached, or low mixed air temperature of 40 degrees F (adjustable) is reached. When mixed air temperature drops below 40 degrees F, or outside air temperature rises above the return air temperature, economizer mode shall be disabled and outside air damper shall reset to a minimum position. Return air damper shall reset to maximum position.

9. Temperature Control System Contractor shall provide filter bank differential pressure devices with interconnection to DDC central computer panel.

10. Activation of duct smoke detectors, area ceiling smoke detectors, or other signals from building fire alarm system shall initiate smoke alarm mode for fan system. Supply fan and relief/return fan shall shut down. Associated system fire/smoke dampers shall shut.

11. CO2 Monitoring: Building DDC control system shall monitor and log the CO2 levels in the building from sensors located in the return air duct main for each air handling unit. Ambient CO2 levels shall be monitored from additional sensor located on the roof. Control shall be as follows:
   a. One (1) CO2 monitoring unit and duct sensor shall be located in return duct upstream of each return fan. Monitor shall be interlocked with electric operated modulating outdoor air intake damper through unit DDC panel.
   b. Upon a drop in carbon dioxide (CO2) level below 700 PPM above ambient (adjustable) in return duct as detected by duct CO2 monitor sensor, the minimum outdoor air volume shall
modulate downward, to a minimum of 15%, or until the CO2 level reaches the setpoint of 700 PPM above ambient setpoint. If mixed air temperature drops below 48 degrees F (adjustable), outside air damper actuator shall stop damper from opening further.

c. If CO2 levels rise above 700 PPM above ambient (adjustable), an alarm shall initiate at the local HVAC unit DDC controller and DDC computer panel. Outdoor air damper shall modulate open to a maximum air capacity setting equal to the design full capacity of the minimum damper setting as measured by the airflow measuring device in outdoor air intake duct.

d. One (1) CO2 monitor unit shall be installed on the roof and interconnected to the building DDC control system. If CO2 levels rise above 700 PPM above ambient (adjustable), an alarm shall signal at the DDC computer.

12. Humidity Control: When humidity in the building rises above 60% (adjustable) in summer mode from sensors located in this return duct main for each air handling unit, building control system shall lock out the economizer mode of the air handling unit for a minimum of four hours (adjustable). Cooling will be provided with outside air dampers at minimum setting.

13. A manual reset low-limit thermostat (set at 40°F, adjustable) located at air handling unit discharge shall stop fans, close OA damper and open heating valve when tripped. An alarm shall be indicated at the central control panel.

1.5 VARIABLE AIR VOLUME TERMINAL UNIT OPERATING SEQUENCE

A. General

1. This control type is for shut-off type VAV boxes with reheat coils.
2. Air terminal units shall be controlled automatically through local electronic (DDC) velocity controllers.
3. The DDC damper actuators shall be provided by this temperature control contractor for field mounting and calibration by this contractor (or for factory mounting at contractor’s option).
4. Pressure Independent Control. Airflow measuring sensors at the air terminal inlet shall provide a signal to control the unit airflow proportionally between the minimum and maximum CFM setpoints regardless of upstream duct pressure.
5. Heating water control valves shall be fully modulating digital two-way throttling valves, normally open, unless otherwise indicated. The temperature control contractor shall provide the valves for field installation by the mechanical contractor.
6. The temperature control contractor shall provide direct digital thermostats and mount/wire.

B. Control Sequence for Variable Air Volume Boxes with reheat coils:

1. A digital space thermostat shall provide a signal to proportionally position the unit damper and the hot water heating coil in sequence to provide cooling or heating to maintain the space temperature setpoint.

2. Occupied Mode:
   a. When the zone temperature is between the occupied heating and cooling setpoints, the primary air damper will be at the minimum CFM and there will be no mechanical heating.
   b. On a rise in zone temperature above the cooling setpoint, the primary air damper will modulate open to the cooling maximum CFM and there will be no mechanical heating.
   c. On a drop in zone temperature below the heating setpoint, the reheat coil shall be enabled. When the reheat coil is enabled, it will modulate to maintain the discharge air temperature setpoint. The discharge air temperature setpoint will be reset as the zone temperature changes. The primary air damper is controlled to provide the minimum heating CFM.

3. Unoccupied Mode:
   a. When in this mode, while the zone temperature is between the unoccupied heating and cooling setpoints, the primary air damper will be at the minimum CFM and there will be no mechanical heating.
b. On a rise in zone temperature above the unoccupied cooling setpoint, the primary air damper will modulate open to cooling maximum (if available) and there will be no mechanical heating.

c. On a drop in zone temperature below the unoccupied heating setpoint, the supplementary heat will be fully utilized before the reheat coil is enabled and the primary air damper will open to the minimum heating CFM.

4. Unit Enable:
   a. A network unit enable signal will control the mode of the box.

5. Alarm:
   a. Generate an alarm when space temperature is out of range. Follow existing VAVs in the building regarding alarm settings.

6. All VAV boxes shall have temperature sensors at discharge of box, monitored at the DDC.

C. Control sequence for Variable Air Volume Boxes with reheat coils and perimeter radiation:

1. A digital space thermostat shall provide a signal to proportionally position the unit damper and the hot water heating coil in sequence to provide cooling or heating to maintain the space temperature setpoint.

2. Occupied Mode:
   a. When the zone temperature is between the occupied heating and cooling setpoints, the primary air damper will be at the minimum CFM and there will be no mechanical heating.
   b. On a rise in zone temperature above the cooling setpoint, the primary air damper will modulate open to the cooling maximum CFM and there will be no mechanical heating.
   c. On a drop in zone temperature below the heating setpoint, the radiation coil will be fully utilized before the reheat coil is enabled. When the reheat coil is enabled, it will modulate to maintain the discharge air temperature setpoint. The discharge air temperature setpoint will be reset as the zone temperature changes. The primary air damper is controlled to provide the minimum heating CFM.

3. Unoccupied Mode:
   a. When in this mode, while the zone temperature is between the unoccupied heating and cooling setpoints, the primary air damper will be at the minimum CFM and there will be no mechanical heating.
   b. On a rise in zone temperature above the unoccupied cooling setpoint, the primary air damper will modulate open to cooling maximum (if available) and there will be no mechanical heating.
   c. On a drop in zone temperature below the unoccupied heating setpoint, the radiation coil will be fully utilized before the reheat coil is enabled and the primary air damper will open to the minimum heating CFM.

4. Auto Warmup:
   a. During warmup mode, VAV box primary air damper shall open to minimum heating CFM position. The reheat coil is enabled and open to provide venting supply air temperature. Once occupied space temperature is achieved, VAV box and reheat shall operate in normal occupied mode.

5. Unit Enable:
   a. A network unit enable signal will control the mode of the box.

6. Alarm:
   a. Generate an alarm when space temperature is out of range. Follow existing VAVs in the building regarding alarm settings.

7. All VAV boxes shall have temperature sensors at discharge of box, monitored at the DDC.

A. Initial Set points:

1. Winter: 69°F (adjustable)
2. Summer: 75°F (adjustable)
B. Operator Station Display: Indicate (as a minimum) the following on operator workstation display terminal:
1. DDC system graphic.
2. Damper position
3. Discharge temperature
4. Thermostat setpoint
5. Actual room temperature
6. High and low room temperature alarms at DDC
7. Reheat coil – on/off
8. Electric coil alarms
9. Provide 30-day summary/history logs of space temperatures and VAV operation
10. CO2 control as applicable:
   a. Carbon dioxide high limit setpoint
   b. Carbon dioxide setpoint
   c. Carbon dioxide indication

1.6 FIN TUBE RADIATION OPERATING SEQUENCE
A. Radiators, Hydronic:
1. This control contractor shall provide DDC control valves as shown on the plans and electronic space temperature sensors. Electronic space temperature sensors may control both the finned tube radiation and a perimeter VAV box.
2. Room Temperature: An electronic sensor will sense and indicate space temperature; the thermostat will control both the finned tube radiation and the perimeter VAV box(es) with reheat coils serving the same area. Refer to Specification Section 230993, 1.5, C – Control Sequence for Variable Air Volume Boxes with reheat coils and perimeter radiation for control sequence.
3. Initial set point 69°F (adjustable).
4. Provide control to enable finned tube radiation devices when outdoor temperature is below 50°F (adjustable) and disabled when outdoor temperature rises above 55°F (adjustable).
5. Display:
   a. Room temperature indication.
   b. Room temperature set point.
   c. Control-valve position.

1.7 CABINET UNIT HEATER OPERATING SEQUENCE
A. This control sequence consists of the cabinet unit heaters, motorized valves and thermostats.
B. Provide the hot water motorized control valves with DDC actuators. The mechanical contractor installs the thermostats.
C. Provide and mount the thermostat on the wall of the space to be heated. Temperature setpoint shall be set from the DDC system.
D. Upon signal from space temperature sensor, energize the fan and modulate the valve to maintain space temperature.
E. Cabinet unit heaters shall be shut off when outdoor temperature exceeds space heating setpoint as referenced from the building DDC system outdoor temperature sensor.
F. Display:
   1. Temperature setpoint at room thermostat
   2. Valve position
   3. Fan status
1.8 MISCELLANEOUS SPACE VENTILATION CONTROL (EF-1 and EF-2)

A. Exhaust fan shall be enabled during occupied periods and disabled during unoccupied periods, as scheduled in the DDC system.

1.9 EXISTING HEATING HOT WATER BOILER SEQUENCE

A. The existing boiler controls and controls connection to the Johnson Controls panel shall remain. Boiler to operate off of existing boiler control module.

B. Provide control from existing boiler controls to operate the new isolation valves (verify terminals are available on the I/O board for wiring connection). Make connections per manufacturers requirements only.

C. Associated boiler isolation valve shall be open when the boiler is designated as the mast boiler. The master boiler shall operate its own isolation valve and send a signal to the slave boiler to open or close their isolation valve. Maser boiler valve shall prove open prior to heating water pump start.

D. Existing outdoor reset control to remain. Coordinate with Owner for outdoor reset schedule changes or updates.

PART 2 PRODUCTS – NOT USED

PART 3 PRODUCTS – NOT USED

END OF SECTION
SECTION 23 09 95
DATA AND CONTROL POINTS LIST

PART 1 – GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes building automation and temperature control partial points list. Additional points maybe required to properly execute a sequence of operation.
B. Related Sections include the following:
   1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.
   2. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.
   3. Division 23 Section "Control Standard for BACNET Integration" for requirements that relate to this Section.

1.3 DEFINITIONS
A. The following are common industry abbreviations for control points:
   1. ASD: Adjustable speed drive.
   2. CC: Cooling Coil
   3. CFM: Cubic feet per minute
   4. FTR: Finned Tube Radiation
   5. GPM: Gallons per minute
   6. HC: Heating coil.
   7. M.A.: Mixed Air
   8. O.A.: Outside Air
   9. R.A.: Return air
   10. RH: Relative humidity
   11. S.P.: Static pressure.
   12. VSD: Variable Speed Drive

1.4 PERFORMANCE REQUIREMENTS
A. The following table is a minimum points list developed to assist the Building Automation System (BAS) provider. The BAS manufacturer and installer shall provide any additional points necessary to perform the sequences of control identified in other Division 23 sections.
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<td>Cooling Temperature Set Point</td>
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<td>High Zone Temperature</td>
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<td>Low Zone Temperature</td>
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Notes
1. High Pressure Limit (positive). Hard-wired to VSD.
2. High Pressure Limit (negative). Hard-wired to VSD.
3. Duct Static Pressure Sensor located toward the end of supply air duct.
4. Coordinate connection requirements with equipment provided.
5. Return air sensors located upstream of minimum outside air duct connection.
6. Global Point. Used for more than one system.
7. Low Temperature Limit. Hard-wired to VSD.
8. Local temperature controls. Hard-wired to equipment.

PART 2 – PRODUCTS – NOT USED

PART 3 – EXECUTION – NOT USED

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Hot-water heating piping.
   2. Condensate-drain piping.
   4. Chemical treatment cleaning and flushing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Plastic pipe and fittings with solvent cement.
   2. RTRP and RTRF with adhesive.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Other building services.
   3. Structural members.

B. Field quality-control reports.

C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
1.6 COORDINATION
A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
B. Coordinate pipe sleeve installations for foundation and exterior wall penetrations. Coordinate with requirements specified in Division 7 Sections for sealing pipe penetrations through exterior and foundation walls.
C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.
D. Coordinate pipe fitting pressure classes with products specified in related Sections.
E. Coordinate power requirements for hydronic specialties with Division 26 installer.
F. Coordinate the installation of hydronic control devices with Section 230900 "Instrumentation and Controls for HVAC".

PART 2 PRODUCTS
2.1 PERFORMANCE REQUIREMENTS
A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 125 psig at 200 degrees F.
   2. Chilled-Water Piping: 125 psig at 200 degrees F.
   3. Condenser-Water Piping: 125 psig at 150 degrees F.
   4. Makeup-Water Piping: 80 psig at 150 degrees F.
   5. Condensate-Drain Piping: 150 degrees F.
   6. Blowdown-Drain Piping: 200 degrees F.
   7. Air-Vent Piping: 200 degrees F.
   8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide copper tubing and fittings manufactured by one of the following:
   b. Cerro Flow Products Incorporated.
   c. Mueller Industries Incorporated.
   d. Nibco Incorporated

B. Drawn-Temper Copper Tubing: ASTM B 88, Type L
C. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
D. DWV Copper Tubing: ASTM B 306, Type DWV.
E. Wrought-Copper Unions: ASME B16.22.
F. Prohibited: ProPress

2.3 STEEL PIPE AND FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide steel pipe manufactured by one of the following:
1. American Steel Pipe; Division of American Cast Iron Pipe Company.
2. Central Steel and Wire Company.
3. LaBarge Pipe and Steel Company.

B. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.


E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

F. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

G. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

H. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

I. Grooved Mechanical-Joint Fittings and Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Anvil International, Inc.
      b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
      c. National Fittings, Inc.
      d. Victaulic Company.
   2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   3. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.

B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
      a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
      b. Adhesive primer shall have a VOC content of 550 g/L or less.
      c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
      a. PVC solvent cement shall have a VOC content of 510 g/L or less.
      b. Adhesive primer shall have a VOC content of 550 g/L or less.
      c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      b. IPEX Inc.
      c. KBI Company.
   2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      b. IPEX Inc.
      c. KBI Company.
      d. NIBCO INC.
   2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.
2.7 CHEMICAL TREATMENT

A. Description: Existing bypass chemical feeder to remain.
   1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
   2. All glycol, cleaning chemicals, and any other water treatment chemical shall be selected with input and approval of the county’s current water treatment vendor (Jaytech, Inc. 1290 Osborne Rd NE, Suite E, Minneapolis, MN 55432, Contact: Andy Morecomb, phone: 1-855-795-8555 email: sales@jaytech.com)

B. Ethylene Glycol: Industrial grade with corrosion inhibitors and environmental stabilizer additives for mixing with water in systems indicated to contain anti-freeze or glycol solutions. Provide a mixture of 30% in heating system by volume, in the water.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Type L, drawn-temper copper tubing, wrought-copper fittings, and pressure-seal joints.
   3. Schedule 40, Grade B, Type 96 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2.5 and 3, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Type L, drawn-temper copper tubing, wrought-copper fittings, and pressure-seal joints.
   3. Schedule 40 steel pipe, wrought-steel fittings, wrought-cast or forged-steel flanges, flange fittings, and welded and flanged joints.

C. Hot-water heating piping, aboveground, NPS 4 and larger shall be the following:
   1. Schedule 40 steel pipe, wrought-steel fittings, wrought-cast or forged-steel flanges, flange fittings, and welded and flanged joints.

D. Hot-water heating piping installed below ground and within slabs shall be the following:
   1. Type K annealed-temper copper tubing:
      a. Install underground tubing without joints.

I. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

M. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer’s written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install exterior underground piping and fittings according to the manufacturer’s published instructions. Provide a minimum of two feet of cover.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Q. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

R. Install unions in steel piping, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

T. Install shutoff valve immediately upstream of each dielectric fitting.

U. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

Z. Install drain traps for each condensate drain pan for cooling coils in air handling units and fan-coil units. Provide vented water seal and terminate with a turned-down elbow at a floor drain.

1. For roof-mounted equipment, provide drain traps with vented water seal and a turned-down elbow to discharge on the roof.

AA. Install drain piping for outside air and relief/exhaust air plenums, and as indicated. Provide a waste fitting on the sheet metal plenum, and extend a turned-down elbow at a floor drain. Do not trap. Do not use plastic pipe.
3.3  DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or flanges.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4  HANGERS AND SUPPORTS
A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet.
   2. NPS 1: Maximum span, 7 feet.
   3. NPS 1-1/2: Maximum span, 9 feet.
   4. NPS 2: Maximum span, 10 feet.
   5. NPS 2-1/2: Maximum span, 11 feet.
   6. NPS 3 and Larger: Maximum span, 12 feet.
D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5  PIPE JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
   4. PVC Non-pressure Piping: Join according to ASTM D 2855.

I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 23 05 19 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
   1. pH: 7.0 to 9.
   2. "P" Alkalinity: 100 to 500 ppm.
   3. Boron: 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
   5. Corrosion Inhibitor:
      a. Sodium Nitrate: 1000 to 1500 ppm.
      b. Molybdate: 200 to 300 ppm.
      c. Chromate: 200 to 300 ppm.
      d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
      e. Chromate Plus Molybdate: 50 to 100 ppm each.
   6. Soluble Copper: Maximum 0.20 ppm.
   7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
   8. Total Suspended Solids: Maximum 10 ppm.
10. Free Caustic Alkalinity: Maximum 20 ppm.
11. Microbiological Limits:
   a. Total Aerobic Plate Count: Maximum 1000 organisms/ml.
   b. Total Anaerobic Plate Count: Maximum 100 organisms/ml.
   c. Nitrate Reducers: 100 organisms/ml.
   d. Sulfate Reducers: Maximum zero organisms/ml.
   e. Iron Bacteria: Maximum zero organisms/ml.

B. General procedure for preparing a new or existing piping system:
   1. Drain, recovering existing glycol for re-use as recommended by the county's water treatment vendor.
   2. Run the initial flush with city water to remove residual treatment from the pipes. After the system is flushed, drain the loop and clean strainers. Flushing procedure shall be continued until the flushed water matches the pH and conductivity of the city water.
   3. Fill system with clean city water. Meter the volume going back into the loop and record the total system volume, and add 15% to account for water held up in the pipes.
   4. Add cleaning chemicals recommended by the county's water treatment vendor to achieve their recommended concentration and circulate for a minimum of 12 hours with all valves open. Adding heat to the system will aid in the cleaning process. After 12 hours, flush the loop with clean city make up water until all cleaner and debris is removed.
   5. Contact the county's water treatment vendor for an inspection to verify that the flush was successful.
   6. After the flush is deemed a success, add 100% Inhibited Ethylene Glycol and clean softened or demineralized water to surpass a 30% concentration by volume.
   7. The county's water treatment vendor will make a final visit to test and report on the concentration. Coordinate with treatment vendor for final visit.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

E. Fill systems indicated to have antifreeze or glycol solutions with deionized water and the following concentrations:
   2. Chilled-Water Piping: See drawings for glycol percentage.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Clean all strainers.
   4. Set makeup pressure-reducing valves for required system pressure.
   5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   6. Set temperature controls so all coils are calling for full flow.
   7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   8. Verify proper chemical treatment for each system.

END OF SECTION
SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.
B. Related Sections include the following:
   1. Division 23 Section "Common Work Results for HVAC" for required piping specialties.

1.2 SUMMARY
A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS
A. Line Test Pressure for Refrigerant R-410A:

1.4 SUBMITTALS
A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure
drop, based on manufacturer’s test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure regulating valves.
B. Welding certificates.
C. Field quality control test reports.
D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in
   maintenance manuals.

1.5 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel
   Code: Section IX, "Welding and Brazing Qualifications."
C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
D. IMC Compliance: Fabricate and install refrigerant piping in accordance with "International
   Mechanical Code" and State Code.

1.6 PRODUCT STORAGE AND HANDLING
A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and
   exterior are clean when installed.

Hennepin County
North Regional Library Refurbishment

Refrigerant Piping

23 23 00 - 1
1.7 COORDINATION
A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS
A. Copper Tube: ASTM B 280, Type ACR.
B. Wrought Copper Fittings: ASME B16.22.
C. Wrought Copper Unions: ASME B16.22.
D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
E. Brazing Filler Metals: AWS A5.8.
F. Flexible Connectors:
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4 inch misalignment in minimum 7 inch long assembly.
   5. Maximum Operating Temperature: 250 deg F.

2.2 STEEL PIPE AND FITTINGS
A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
B. Wrought Steel Fittings: ASTM A 234/A 234M, for welded joints.
C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel welded end connection, and raised face.
E. Flanged Unions:
   1. Body: Ductile iron for NPS 2 to NPS 3. Apply rust resistant finish at factory.
   2. Gasket: Fiber asbestos free.
   3. Fasteners: Four plated steel bolts, with silicon bronze nuts. Apply rust resistant finish at factory.
   4. End Connections: Brass tailpiece adapters for solder end connections to copper tubing.
   5. Offset Performance: Capable of minimum 3/4 inch misalignment in minimum 7 inch long assembly.
   7. Maximum Operating Temperature: 330 deg F.
F. Flexible Connectors:
   1. Body: Stainless steel bellows with woven, flexible, stainless steel wire reinforced protective jacket
   2. End Connections:
      a. NPS 2 and Larger: With flanged end connections.
   3. Offset Performance: Capable of minimum 3/4 inch misalignment in minimum 7 inch long assembly.
   5. Maximum Operating Temperature: 250 deg F.
2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
   1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
   3. Operator: Rising stem and hand wheel.
   5. End Connections: Socket, union, or flanged.
   7. Maximum Operating Temperature: 275 deg F.

B. Packed Angle Valves:
   1. Body and Bonnet: Forged brass or cast bronze.
   2. Packing: Molded stem, back seating, and replaceable under pressure.
   3. Operator: Rising stem.
   5. Seal Cap: Forged brass or valox hex cap.
   6. End Connections: Socket, union, or flanged.
   8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
   1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
   2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
   6. End Connections: Socket, union, or flanged.
   7. Maximum Opening Pressure: 0.50 psig.
   9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball type check valve with stainless steel spring.
   4. End Connections: Copper spring.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2” (16-GRC) conduit adapter, and 24 or 115-Volt ac coil.
   7. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   4. End Connections: Threaded.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Suction Temperature: 40 deg F.
   7. Reverse flow option (for heat pump applications only).
   8. End Connections: Socket, flare, or threaded union.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   5. Seat: Polytetrafluoroethylene.
   7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2” (16-GRC) conduit adapter, and 24 or 115-Volt ac coil.
 11. Maximum Operating Temperature: 240 deg F.

I. Straight Type Strainers:
   2. Screen: 100-mesh stainless steel.
   3. End Connections: Socket or flare.
   5. Minimum Operating Temperature: 275 deg F.

J. Angle Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain Plug: Brass hex plug.
   3. Screen: 100-mesh monel.
   4. End Connections: Socket or flare.
   6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   5. End Connections: Socket or flare.
   7. Maximum Operating Temperature: 240 deg F.

L. Replaceable Core Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted steel shell with ductile iron cover, stainless steel screws, and neoprene gaskets.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.

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4. Designed for reverse flow (for heat pump applications only).
5. End Connections: Socket.
9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with ARI 730.
2. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
4. Designed for reverse flow (for heat pump applications only).
5. End Connections: Socket.
6. Access Ports: NPS 1/4" connections at entering and leaving sides for pressure differential measurement.
9. Maximum Operating Temperature: 240 deg F.

N. Mufflers:
2. End Connections: Socket or flare.
4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code for receivers larger than 6 inches; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket.
7. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with ARI 495.
2. End Connections: Socket.
4. Maximum Operating Temperature: 275 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn temper tubing and wrought copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines:
1. NPS 1 and Smaller: Copper, Type ACR, drawn temper tubing and wrought copper fittings with brazed or soldered joints.
2. NPS 1-1/4 and Smaller: Copper, Type ACR, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.
3. NPS 2: Copper, Type ACR, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.
4. NPS 4: Schedule 40, black steel and wrought steel fittings with welded joints.
C. Safety Relief Valve Discharge Piping:
   1. NPS 1 and Smaller: Copper, Type ACR, drawn temper tubing and wrought copper fittings with brazed or soldered joints.
   2. NPS 1-1/4 and Smaller: Copper, Type ACR, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.
   3. NPS 2: Copper, Type ACR, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.
   4. NPS 4: Schedule 40, black steel and wrought steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless or packed angle valves in suction and discharge lines of compressor.
B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
D. Except as otherwise indicated, install diaphragm packless or packed angle valves on inlet and outlet side of filter dryers.
E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
F. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction line pressure at bulb location.
G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety relief valve discharge line to outside according to ASHRAE 15.
H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.
J. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
K. Install receivers sized to accommodate pump down charge.
L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
B. Install refrigerant piping according to ASHRAE 15.
C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Sections “Instrumentation and Control for HVAC” and “Sequence of Operations for HVAC Controls” for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
   1. Shot blast the interior of piping.
   2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician’s tape.
   3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
   4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
   5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
   6. Safety relief valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers.

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

U. Seal pipe penetrations through exterior walls.

V. Identify refrigerant piping and valves according to Division 23 Section “Identification for HVAC Piping and Equipment.”
3.4 PIPE JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
D. Soldered Joints: Construct joints according to ASTM B 828 or CDA’s “Copper Tube Handbook.”
E. Brazed Joints: Construct joints according to AWS’s “Brazing Handbook,” Chapter “Pipe and Tube.”
   1. Use Type BcuP, copper phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium free silver alloy for joining copper with bronze or steel.
F. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS
A. Provide hanger, support, and anchor devices complying with Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”

3.6 FIELD QUALITY CONTROL
A. Perform tests and inspections and prepare test reports.
B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high and low pressure side piping of each system separately at not less than the pressures indicated in Part 1 “Performance Requirements” Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING
A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 300 micrometers. Close the vacuum line. If vacuum holds at least 500 micrometers for one hour without the assistance of a vacuum pump, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter dryer core in charging line.

3.8 ADJUSTING
A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
B. Adjust high and low pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
D. Perform the following adjustments before operating the refrigeration system, according to manufacturer’s written instructions:
   1. Verify that compressor oil level is correct.
   2. Open compressor suction and discharge valves.
   3. Open refrigerant valves except bypass valves that are used for other purposes.
   4. Check open compressor motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION
SECTION 23 31 13
METAL DUCTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2-inches to plus 10-inches w.g. Metal ducts include the following:
   1. Rectangular ducts and fittings.
   2. Single-wall round longitudinal-seam ducts and formed fittings.
   4. Double-wall, round and flat oval spiral-seam ducts and formed fittings.
   5. Duct liner.
B. Related Sections include the following:
   1. Refer to Division 7 Section "Joint Sealants" for fire-resistant sealants for use around duct penetrations and fire-smoke damper installations in fire-smoke rated floors, partitions, and walls.
   2. Refer to Division 8 Section "Access Doors" for wall and ceiling-mounted access doors for access to concealed ducts.
   3. Refer to Division 10 Sections “Louvers and Vents" for intake air, exhaust air, and relief air louvers connected to ducts and installed in exterior walls.
   4. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS
A. Exposed Duct: Ducts that are visible; except in mechanical equipment rooms.

1.4 SYSTEM DESCRIPTION
A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout would provide original design results without increasing system total pressure.

1.5 SUBMITTALS
A. Product Data: Include details of construction, materials, and dimensions of individual components, profiles, and finishes for the following items:
   1. Fire Stopping Materials.
   2. Duct Transverse Joints.
   3. Liners and adhesives.
   4. Sealants and gaskets.
   5. Seismic-restraint devices.
   6. Duct Connection Systems
B. Shop Drawings: Drawn to scale not smaller than 1/4 inch equals 1 foot. Show fabrication and installation details for the size and types of metal ducts in the Project.
1. Duct fabrication, assembly, and installation details.
2. Duct sizes and materials thickness for the various systems and duct pressure classes.
3. Sealing class.
4. Fittings.
5. Reinforcement and spacing.
6. Seam and joint construction.
7. Penetrations through fire-rated and other partitions.
8. Hangers and supports.
11. Plenums.

C. Welding certificates.
D. Field quality-control test reports.

1.6 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to:

B. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS
A. Comply with SMACNA’s "HVAC Duct Construction Standards—Metal and Flexible" for acceptable materials, material thickness, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653 and having G90 coating designation.
   1. Ducts shall have mill-phosphatized "Paint-Grip" finish for surfaces of ducts exposed to view that are scheduled for field painting.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
   1. Black steel reinforcement may be used on galvanized sheet metal ducts and on aluminum or stainless steel ducts if painted with zinc-chromate primer prior to fabrication.
   2. Use aluminum or stainless steel reinforcement on aluminum or stainless steel ducts exposed to view.

D. Tie Rods: Galvanized steel, 3/8-inch minimum diameter. Rigid conduit, minimum 3/4-inch, can be used in accordance with referenced standards.
2.3 SEALANT MATERIALS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the
      manufacturers specified.
      1. Ductmate Industries, Incorporated (PROseal & FIBERseal)
   B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured,
      UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
   C. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM
      C 920, Type S, Grade NS, Class 25, use O.
   D. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 FIRESTOPPING
   A. Refer to Division 7 for fire-resistant sealants and fire-stopping materials for use around duct
      penetrations and fire damper installations in fire rated floors, partitions, and walls.

2.5 HANGERS AND SUPPORTS
   A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners
      appropriate for construction materials to which hangers are being attached.
      1. Use powder-actuated concrete fasteners for standard-weight aggregate concrete’s or for slabs
         more than 4 inches thick.
      2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concrete’s
         or for slabs less than 4 inches thick.
      3. Exception: Do not use powder-actuated concrete fasteners in post-tensioned concrete slabs
         where the cable locations are not known. Fasteners shall not exceed 3/4-inch embedment.
   B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
      1. Hanger’s installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized
         rods with threads painted with zinc-chromate primer prior to installation.
      2. Strap and Rod Sizes: Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and
         Flexible" for steel sheet width and thickness and for steel rod diameters.
      3. Use stainless steel straps or rods for stainless steel ducts exposed to view. Steel materials may
         be used for concealed ducts if painted with zinc-chromate primer prior to installation.
      4. Use aluminum straps or rods for aluminum steel ducts exposed to view. Steel materials
         may be used for concealed ducts if painted with zinc-chromate primer prior to installation.
   C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with
      duct materials.
   D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36.
      1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates. Black steel shapes
         and plates may be used if painted with zinc-chromate primer prior to installation.
      2. Supports for Stainless-Steel Ducts: Stainless-steel support materials if ducts are exposed to
         view. Steel materials may be used for concealed ducts if painted with zinc-chromate primer
         prior to installation.
      3. Supports for Aluminum Ducts: Aluminum supports materials if ducts are exposed to view. Steel
         materials may be used for concealed ducts if contact surfaces are painted with zinc-chromate
         primer prior to installation.

2.6 DUCT FABRICATION-GENERAL
   A. Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible," and with the
      requirements of this Section.
   B. Comply with SMACNA’s “Rectangular Industrial Duct Construction Standards” for acceptable
      materials, material thickness, and duct construction methods outside the scope of SMACNA’s
C. Duct Pressure Classification: Construct duct systems for the following pressure classifications:

1. Supply Air Ducts:
   a. Supply air ducts on variable-volume air systems between fan outlet and air terminal units: 4-inches water gage positive pressure.
   b. Supply air ducts on all constant volume air systems, and all supply ducts downstream of air terminal units on variable volume air systems: 2 inches water gage, positive pressure.

2. Return and Relief Air Ducts: 2 inches water gage, negative pressure.

3. Exhaust Air Ducts: 2 inches water gage, negative pressure.

4. Other Ducts: 2 inches water gage positive or negative pressure.

D. Duct Sealing Classification: Provide SMACNA “Seal Class A” for all duct pressure classifications.

1. Seal all transverse joints, longitudinal seams, and duct penetrations.

2. Seal to achieve no visible or audible leaks.

E. Materials: All ducts shall be galvanized steel, except as specifically noted on the drawings.

2.7 RECTANGULAR DUCT FABRICATION

A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals, and with the requirements of this Section.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

3. Calculations: When duct construction is outside the scope of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," provide calculations to demonstrate compliance with Duct Pressure Classification.

B. Transverse Joints:

1. Prefabricated Slide-On Joints and Components:
   a. Manufacturers:
      1) Ductmate Industries, Inc.
      2) Elgen Manufacturing
      3) Nexus Inc.
      4) Ward Industries, Inc.
   b. Apply joints using manufacturer’s “Duct Construction Standards” for material thickness, reinforcement size and spacing, and joint reinforcement. “Duct Construction Standards” must be based on the referenced SMACNA Standards. "Duct Construction Standards" shall be submitted as shop drawings, and must be available upon request at the Project Site.
   c. Slide-on joints must include the use of corners, bolts, cleats, and gaskets.
   d. Gaskets must be suitable for application at temperatures experienced at the Project Site.

2. Formed-On Flanges:
   a. Manufacturers:
      1) Ductmate Industries Incorporated
      2) Elgen Manufacturing
      3) T.D.C.
      4) T.D.F.
   b. Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Table 1-12. Formed-on flanges shall be constructed as T-25A (T.D.C.) and T-25B (T.D.F.) joints.
   c. Formed-on flanges must include the use of corners, bolts, cleats, and gaskets.
   d. Gaskets must be suitable for application at temperatures experienced at the Project Site.
e. Duct Size: Maximum 42-inches wide and up to 4-inches wg pressure class.

f. Duct Size: Maximum 60-inches wide and up to 2-inches wg pressure class.

3. Slips and Drives (Traditional):
   a. Construct according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible," Tables 1-11 or 1-12s.

C. Longitudinal Seams: Pittsburgh-lock sealed with non-curing polymer sealant.

D. Internal Tie Rod Reinforcements: Do not use a transverse or intermediate reinforcement that requires the use of internal tie rods on ducts less than 96-inches wide.

E. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of non-braced panel area unless ducts are lined.

F. All-Welded Construction: Provide continuously welded longitudinal and transverse duct joints and seams on ducts as indicated.

G. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division 23 section "Ductwork Accessories" for accessory requirements.

H. Fabricate ductwork so as to be free from vibration, rattling, or "oil-canning" under all operating conditions.

I. Unless otherwise indicated, the net free area of the duct dimensions given on the Drawings shall be maintained. The duct dimensions shall be increased as necessary to compensate for liner thickness.

2.8 RECTANGULAR DUCT FITTINGS

A. General: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA's "HVAC Metal Duct Construction Standards-Metal and Flexible," Figures 2-1 through 2-10.

B. Elbows and Divided Flow Fittings: Fabricate fittings with a centerline radius equal to 1.5 times the associated duct widths up to 28 inches wide, and 1.0 times the duct width for ducts 30 inches wide and wider. Figure 2-2; Type RE 1 radius elbow.
   1. Where elbows with a shorter radius are necessary, fabricate elbows with a 4-inch throat radius, full radius heel, and with short radius vanes. Figure 2-2, Type RE-3. Fabricate short radius vanes according to Appendix pages A.41, A.42 and A.43.
   2. Do not use square elbows, except where indicated on the Drawings. Where used, fabricate square elbow with single-wall turning vanes.

C. Transitions and Offsets: Limit concentric transitions to 45 degrees for diverging, and 60 degrees for converging; limit single-sided transitions to 22.5 degrees for diverging and 30 degrees for converging. Limit angled offsets to a maximum of 30 degrees.

D. Branch Connections: Fabricate branch connections according to Figure 2-6 using clinch lock joints and 45-degree entry.

2.9 ROUND AND FLAT-OVAL DUCT FABRICATION

A. Fabricate ducts according to SMACNA’s "HVAC Duct Construction Standards-Metal and Flexible," Tables 3-2 and 3-3.

B. Duct Pressure Classification and Duct Sealing Classification: As indicated in previous Article “Duct Fabrication, General.”

C. Round Longitudinal Lock-Seam Ducts 14-inches and smaller:
   1. Manufacturers:
      a. Ductmate Industries, Incorporated
   2. Fabricate round ducts with longitudinal grooved "Green Seam" snap lock pipe. Figure 3-1, Type RL-5.
3. Longitudinal snaplock seams may be used for round duct diameters 14-inches and smaller for 2-Inch Duct Pressure Classifications. Figure 3-1, Type RL-6, RL-7, RL-78.

D. Round and Flat Oval, Longitudinal and Spiral-Lock-Seam Ducts 16-inches and larger:
1. Manufacturers:
   b. Semco Incorporated.
   c. Sheetmetal Connectors Incorporated.
2. Fabricate round ducts with spiral lockseam. Figure 3-1, Type RL-1.
3. Fabricate round ducts with longitudinal grooved seam. Figure 3-1, Type RL-5.
4. Provide continuous butt-welded longitudinal seams on ducts larger than 72-inches, and where otherwise indicated. Figure 3-1, Type RL-4.

E. Transverse Duct Joints.
1. Manufacturers:
   a. Ductmate Industries Incorporated.
   b. Elgen Manufacturing
   c. Semco Incorporated.
2. Duct up to 20-Inches Diameter: Interior, center-beaded slip coupling. Figure 3-2, Type TR-1.
   a. Beaded crimp joints may be used for round duct diameters 14-inches and smaller for 2-Inch Duct Pressure Classifications. Figure 3-2, Type TR-5.
   b. Prefabricated self-sealing gasketed coupler: Ductmate "Bullet Band".
3. Ducts 21 to 72-Inches Diameter: Prefabricated three-piece, gasketed, flanged joint consisting of two inner ring flanges with sealant and one external closure band with gasket. Ductmate "Spiralmate" or equivalent.
   a. Prefabricated flanged joint consisting of two external flanges with sealant and gasket may be used for concealed ducts. Ductmate “Econoflange,” Semco “Accuflange,” or equivalent.
   b. Prefabricated self-sealing gasketed coupler: Ductmate "Bullet Band”.
4. Ducts larger than 72-Inches Diameter: Companion angle flanged joints with gasket, sealed before and after fastening. Figure 3-2, Type RT-2.
   a. Prefabricated self-sealing gasketed coupler: Ductmate “Bullet Band”.
5. Joints shall be made with mechanical fasteners (sheet metal screws, blind rivets, welds, bolts). Use sealer before and after fastening.
6. Traverse Duct Joints on exposed ducts.
   a. Prefabricated self-sealing gasketed coupler: Ductmate “Bullet Band”.

F. Unless otherwise indicated, the net free area of the duct dimensions given on the Drawings shall be maintained. The duct dimensions shall be increased as necessary to compensate for liner thickness

2.10 ROUND AND FLAT OVAL DUCT FITTING FABRICATION
A. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Elgen Manufacturing
   d. Semco Incorporated.
   e. Sheetmetal Connectors Incorporated. (www.smcduct.com)
B. General: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standards-Metal and Flexible," Figures 3-3 through 3-5.
   1. Duct fittings shall be fabricated from metal thickness not less than required for longitudinal- seam straight duct in Tables 3-2 and 3-3.
C. Round Duct Takeoffs from Rectangular Ducts: Fabricate takeoffs with clinch-lock or spin-in conical connectors with volume dampers.
   1. Straight connectors may be used for 2-inch Duct Pressure Classification.
D. Elbows: Fabricate with welded seam, die-formed or segmented construction with bend radius 1.5 times the elbow diameter.
   1. Die-Formed Elbows (8-Inches and smaller): Fabricate elbows with two-piece, die-formed construction.
   2. Segmented Elbows (Larger than 8-Inches): Fabricate elbows with multiple segments or gores with number of pieces as follows:
      a. 90 degrees - 5 pieces.
      b. 60 degrees - 4 pieces.
      c. 45 degrees - 3 pieces.
      d. 30 degrees - 2 pieces.
   3. 90 degrees, Two-piece Mitered Elbows: Use only where space restrictions do not permit the use of radius elbows. Fabricate elbows with single thickness turning vanes.
   4. Adjustable Mitered Elbow (14-Inches and Smaller): Adjustable seam, mitered elbows (4-piece 90 degree, 3-piece 45 degree) with bend radius 0.6 times the elbow diameter may be used for 2-inch Duct Pressure Classifications. Joints shall be sealed after installation.

E. Laterals, Tees and Wyes: Fabricate with welded seam construction with conical branch taps with no excess material projecting from body into branch tap entrance.
   1. Straight branch taps may be used for 2-inch Duct Pressure Classification.
   2. Fittings with riveted or bonded joints may be used for duct diameters 16-inches and smaller for 2-inch Duct Pressure Classification. Joints shall be sealed after installation.

F. Diverging-Flow Fittings: Fabricate with welded seam with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," and the requirements of this Section.

C. Install ducts according to SMACNA's "Rectangular Industrial Duct Construction Standards" when duct construction is outside the scope of SMACNA's "HVAC Duct Construction Standards-Metal and Flexible."

D. Construct and install each duct system according to the Duct Pressure Classification and Duct Sealing Classification indicated in previous Article "Duct Fabrication, General."

E. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

F. Install fabricated fittings for changes in directions, size, and shape and for connections.

G. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

H. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

I. Provide offset fittings where necessary to avoid structural interference’s and in coordination with existing conditions and the Work of other trades.
J. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Provide a minimum clearance of 1 inch, plus an allowance for insulation thickness to other elements.

K. Install ducts as high as possible, unless otherwise indicated. Where overhead structure permits, route ducts between structural elements.

L. Conceal ducts from view in finished spaces by locating within mechanical shafts, within hollow construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions unless specifically indicated.

M. Where exposed to view; install ducts as high as possible, unless otherwise indicated. Protect exposed duct from physical damage. Repair scratches, dents, cuts, and other physical imperfections. Remove stickers and markers. Prepare for field painting. Grind and polish exposed welds on un-insulated ducts and double wall ducts so no roughness shows and contours of welded surfaces match adjacent contours.

N. Install insulated ducts with 1-inch clearance outside of insulation.

O. Coordinate the duct layout with suspended ceiling, fire and smoke-control dampers, piping, lighting layouts and conduits, and the Work of other trades.

P. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

Q. One hour rated fire barrier penetrations: (Where the building code allows fire barrier penetrations without fire dampers) Provide angles on both sides of the wall penetrations conforming to the requirements of wall system approval.

R. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and fire stopping sealant.
   1. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."
   2. Fire stopping materials and installation methods are specified in Division 7 Section "Fire stopping."

S. Protect duct interiors from elements and foreign materials until building is enclosed. Refer to SMACNA’s "Duct Cleanliness for New Construction."

3.2 WALL LOUVERS

A. Provide watertight air plenum with soldered drain pan at each louver. Connect air plenum directly to louver frame. The air plenum drain pan shall be arranged to drain to a threaded drain connection. Extend plenum drain untrapped to a floor drain.

B. Provide 2 inch thick insulated double-wall blank-off panels at each unused wall louver. Blank-off panels shall be attached to the louver frame with a gasketed, watertight connection

3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

B. Duct Sealing Classification: Provide SMACNA “Seal Class A” for all duct pressure classifications.
   1. Seal all transverse joints, longitudinal joints, and duct penetrations.
   2. Seal to achieve no visible or audible leaks.

C. Seal externally insulated ducts before insulation is applied.

D. Seal exposed joints internally during installation. Do not use external sealant on exposed ducts.
3.4 HANGING AND SUPPORTING
A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
D. Install concrete inserts before placing concrete.
E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs greater than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured.
   3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3.5 CONNECTIONS
A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
B. For branch connections comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," Figures 2-5 and 2-6.
C. For inlet and outlet connections comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," Figures 2-14 and 2-15.
D. For equipment connections comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figures 2-17.

3.6 PAINTING
A. Exposed galvanized ducts: Paint materials and methods are specified in Division 9 Sections.

3.7 FIELD QUALITY CONTROL
A. Perform field tests and inspections according to SMACNA’s “HVAC Air Duct Leakage Test Manual” and prepare test reports.
B. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
C. Conduct tests at static pressures equal to Duct Pressure Classification designated static pressures.
D. Conduct tests in the presence of the Architect, or authorized representative. Give 7 day’s advanced notice for testing. Prepare test reports.
E. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
F. Leakage Tests:
   1. Leak test each section of duct with a Duct Pressure Classification greater than 2-inches wg.
   2. Leak test each section of duct within a concealed shaft.
   3. Leak test each section of laboratory fume hood exhaust duct.
4. Leak test a representative section of duct with a Duct Pressure Classification of 2-inches or less. Test a section with a positive pressure classification, and a section with a negative pressure classification.
   a. Following a successful test, all other ductwork in the Duct Pressure Classification shall be visually inspected to assure duct construction methods are like the tested sections.
   b. Additional sections shall be tested as requested by the Architect.

G. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for ducts with a Duct Pressure Classification greater than 2-inches, and for Leakage Class 6 for ducts with duct pressure classification 2-inches or less.
   a. For a duct section with 4-inch Duct Pressure Classification or greater and Duct Leakage Class 3, leakage shall not exceed 7.5 CFM per 100 sq. ft. of duct surface area.
   b. For a duct section with a 2-inch Duct Pressure Classification and Duct Leakage Class 6, leakage shall not exceed 9.5 CFM per 100 sq. ft. of duct surface area.
   c. For positive pressure exhaust ducts, leakage shall be zero at 4.0 inches w.g.

3.8 TEMPORARY USE OF AIR HANDLING SYSTEMS

A. Refer to Division 1 Section 01510 “Temporary Utilities” for additional requirements.

B. Until the permanent air handling systems are used, duct openings shall have closures to preclude the entry of construction dirt and debris into the duct system and equipment.

C. If the permanent air handling systems are used for temporary heating or ventilating prior to completion of finishing operations, the supply air systems shall be operated with 100 percent outside air (no recirculation air) with pre-filters and final filters in place and maintained.
   1. Operation of air handling systems may not be possible during extreme outside air conditions.
   2. The return air and exhaust air systems shall not be used. The duct openings on these systems shall have permanent closures.

D. When the building is substantially complete, the permanent air handling systems may be utilized with return air with air filters in place. Extra-ordinary measures shall be taken to prevent dirt and/or moisture from entering the duct systems.
   1. Filters: Maintain clean filters in place. Install new permanent filters prior to Owner occupancy of the Project.
   2. Equipment: Maintain fans and equipment until Owner occupancy of the Project.

E. Air handling system ducts shall be vacuum cleaned, and equipment surfaces washed as may be necessary to restore the systems to new condition prior to final acceptance by the Owner.

3.9 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.
   1. Create other openings to comply with duct standards.
   2. Disconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:
   1. Visually inspect metal ducts for contaminants.
   2. Where contaminants are discovered, re-clean and re-inspect ducts.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   2. Fire dampers.
   3. Flange connectors.
   4. Turning vanes.
   5. Remote damper operators.
   6. Duct-mounted access doors.
   7. Flexible connectors.
   8. Flexible ducts.
   9. Duct accessory hardware.
B. Related Requirements:
   1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      c. Control-damper installations.
      d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      e. Duct security bars.
      f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
B. Source quality-control reports.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Air Balance Incorporated; a Division of Mestek, Incorporated. (www.airbalance.com)
      b. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
      d. McGill AirFlow LLC. (www.mcgillairflow.com)
      e. Nailor Industries Incorporated. (www.nailor.com)
      f. Pottorff. (www.pottorff.com)
      g. Ruskin Company. (www.ruskin.com)
      h. Trox USA Incorporated. (www.troxsusa.com)
      i. Vent Products Company, Incorporated. (www.ventproducts.com)
   2. Standard leakage rating, with linkage outside airstream.
   3. Maximum air velocity: 1500 fpm.
   4. Suitable for horizontal or vertical applications.
   5. Frames:
      a. Frame: 5-inches wide, Hat-shaped, 0.064-inch thick, galvanized sheet steel with reinforced corners.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   6. Blades:
      a. Multiple or single blade.
      b. 6-inches wide.
      c. Parallel- or opposed-blade design.
      d. Stiffen damper blades for stability.
      e. Galvanized-steel, 0.064 inch thick.
   7. Bearings:
      a. Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle’s full length of damper blades and bearings at both ends of operating shaft.
   8. Tie Bars and Brackets: Galvanized steel.
B. Standard, Steel, Manual Volume Dampers: Maximum air velocity 3,000 fpm.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Incorporated; a Division of Mestek, Incorporated. (www.airbalance.com)
   b. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
   c. Flexmaster U.S.A., Inc. (www.flexmasterusa.com)
   d. McGill AirFlow LLC. (www.mcgillairflow.com)
   e. Nailor Industries Incorporated. (www.nailor.com)
   f. Pottorff. (www.pottorff.com)
   g. Ruskin Company. (www.ruskin.com)
   h. Trox USA Incorporated. (www.troxusa.com)
   i. Vent Products Company, Incorporated. (www.ventproducts.com)

2. Standard leakage rating, with linkage outside airstream.
4. Suitable for horizontal or vertical applications.
5. Frames:
   a. Frame: 5-inches wide, Hat-shaped, 0.064-inch thick, galvanized sheet steel with reinforced corners.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
   a. Multiple or single blade.
   b. 6-inches wide.
   c. Parallel- or opposed-blade design.
   d. Double skin air foil damper blades.
   e. Galvanized-steel, 0.078 inch thick.
8. Bearings:
   a. Stainless steel sleeve.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle’s full length of damper blades and bearings at both ends of operating shaft.

C. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Incorporated; a Division of Mestek, Incorporated. (www.airbalance.com)
   b. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
   c. McGill AirFlow LLC. (www.mcgillairflow.com)
   d. Nailor Industries Incorporated. (www.nailor.com)
   e. Pottorff. (www.pottorff.com)
   f. Ruskin Company. (www.ruskin.com)
   g. Trox USA Incorporated. (www.troxusa.com)
   h. Vent Products Company, Incorporated. (www.ventproducts.com)

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.125-inch thick, extruded aluminum channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
      1) Stiffen damper blades for stability.
   c. Extruded-Aluminum Blades: 0.0125-inch thick extruded aluminum.
7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle’s full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Aluminum.

D. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Incorporated; a Division of Mestek, Incorporated. (www.airbalance.com)
   b. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
   c. McGill AirFlow LLC. (www.mcgillairflow.com)
   d. Nailor Industries Incorporated. (www.nailor.com)
   e. Pottorff. (www.pottorff.com)
   f. Ruskin Company. (www.ruskin.com)
   g. Trox USA Incorporated. (www.troxusa.com)
   h. Vent Products Company, Incorporated. (www.ventproducts.com)
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA’s Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
   a. Hat shaped.
   b. 0.094-inch thick, galvanized sheet steel.
   c. Mitered and welded corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel, 0.064 inch thick.
8. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle’s full length of damper blades and bearings at both ends of operating shaft.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:
   a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. Low-Leakage, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Incorporated; a Division of Mestek, Incorporated. (www.airbalance.com)
   b. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
   c. McGill AirFlow LLC. (www.mcgillairflow.com)
   d. Nailor Industries Incorporated. (www.nailor.com)
   e. Pottorff. (www.pottorff.com)
   f. Ruskin Company. (www.ruskin.com)
   g. Trox USA Incorporated. (www.troxusa.com)
   h. Vent Products Company, Incorporated. (www.ventproducts.com)
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA’s Certified Ratings Seal for both air performance and air leakage.
Suitable for horizontal or vertical applications.

5. Frames: Hat shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.


8. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle’s full length of damper blades and bearings at both ends of operating shaft.


11. Tie Bars and Brackets: Galvanized steel.

12. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

F. Jackshaft:
   1. Size: 0.5-inch diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

G. Damper Hardware:
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.

2.3 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance Incorporated; a Division of Mestek, Incorporated. (www.airbalance.com)
   2. Arrow United Industries; a Division of Mestek, Incorporated. (www.arrowunited.com)
   3. Cesco Products; a Division of Mestek, Incorporated. (www.cescoproducts.com)
   6. NCA Manufacturing, Incorporated. (www.ncamfg.com)
   7. Potterff. (www.pottorff.com)
   8. Prefco; Perfect Air Control, Incorporated. (www.prefco-hvac.com)

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
   1. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
   2. Fire Rating: 1-1/2 and 3 hours.
   3. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
      a. Minimum Thickness: 0.064 thick, as indicated, and of length to suit application.
      b. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
5. Mounting Orientation: Vertical or horizontal as indicated.
6. Blades: Roll-formed, interlocking, 0.064 thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
7. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

2.4 FLANGE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Incorporated. (www.ductmate.com)
   2. Elgen Manufacturing. (www.elgenmfg.com)
   3. Nexus PDQ; Division of Shilco Holdings Incorporated. (www.nexuspdq.com)
B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
   1. Material: Galvanized steel.
   2. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Incorporated. (www.ductmate.com)
   2. Elgen Manufacturing. (www.elgenmfg.com)
B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
C. General Requirements: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanex and Vane Runners," and 4-4, "Vane Support in Elbows."
   1. Vane Construction: Single and Double wall.
   2. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.6 REMOTE DAMPER OPERATORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff. (www.pottorff.com)
   2. Ventfabs, Incorporated. (www.ventfabs.com)
   3. Young Regulator Company. (www.youngregulator.com)
B. Description: Cable system designed for remote manual damper adjustment.
   1. Tubing: Aluminum.
   2. Cable: Stainless steel.
   3. Wall-Box Mounting: Recessed.
   4. Wall-Box Cover-Plate Material: Steel.

2.7 DUCT-MOUNTED ACCESS DOORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
   2. Cesco Products; a Division of Mestek, Incorporated. (www.cescoproduits.com)
   4. Elgen Manufacturing. (www.elgenmfg.com)

   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges or Continuous and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Three hinges or Continuous and two compression latches with outside and inside handles.
      d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
   1. Door and Frame Material: Galvanized sheet steel.
   2. Door: Single wall for uninsulated ducts and double wall with insulation fill for insulated ducts. Duct material metal thickness applicable for duct pressure class.
   3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
   4. Factory set at 3.0- to 8.0-inch wg.
   5. Doors close when pressures are within set-point range.
   6. Hinge: Continuous piano.
   7. Latches: Cam.
   8. Seal: Neoprene or foam rubber.

2.8 DUCT ACCESS PANEL ASSEMBLIES
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Pottorff. (www.pottorff.com)
      2. Ruskin Company. (www.ruskin.com)
   B. Labeled according to UL 1978 by an NRTL.
   C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
   D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
   E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
   F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.9 FLEXIBLE CONNECTORS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Duro Dyne Incorporated. (www.durodyne.com)
c. Elgen Manufacturing. (www.elgenmfg.com)
d. Ventfabrics, Incorporated. (www.ventfabrics.com)
e. Ward Industries, Incorporated; a Division of Hart & Cooley, Incorporated. (www.hartandcooley.com)

4. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.
   b. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   c. Service Temperature: Minus 40 to plus 200 deg F.
   b. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   c. Service Temperature: Minus 50 to plus 250 deg F.
   b. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
   c. Service Temperature: Minus 67 to plus 500 deg F.
   b. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   c. Service Temperature: Minus 67 to plus 500 deg F.
9. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   a. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   b. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   g. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.10 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. ThermaFlex (www.thermaflex.net)

B. Non-insulated-Flexible Duct: UL 181, Class 1, heavy-coated fiberglass cloth supported by helically wound, spring-steel wire.
   1. Pressure Rating:
      a. Sizes 2-inches to 10-inches: 16-inch wg positive and 1.0-inch wg negative.
      b. Sizes 12-inches to 20-inches: 10-inch wg positive and 1.0-inch wg negative.
3. Temperature Range: Minus 20 to plus 250 Degrees.
4. Examples: Flexmaster U.S.A., Incorporated (Type NI-45); Thermaflex (Model S-TL)

C. Insulated-Flexible Duct: UL 181, Class 1, heavy-coated fiberglass cloth liner supported by helically wound, spring-steel wire. Fiberglass insulation R-4.2 with aluminized vapor barrier.
   1. Pressure Rating:
      a. Sizes 2-inches to 10-inches: 16-inch wg positive and 1.0-inch wg negative.
      b. Sizes 12-inches to 20-inches: 10-inch wg positive and 1.0-inch wg negative.
3. Temperature Range: Minus 20 to plus 250 Degrees

D. Flexible Duct Connectors:
   1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE
   1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
   2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
   B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
   C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
      1. Duct openings shall be free of any obstruction or irregularities that interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4" larger than damper dimensions and shall be square, straight, and level.
      2. Multiple damper sections will be square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be equal ±1/8-inches.
      3. Install extended shaft or jackshaft per manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
      4. Damper blades, axles, and linkage shall operate without binding. Before system operation, cycle damper after installation to assure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
      5. Provide a visible and accessible indication of damper position on the drive shaft end.
      6. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
   D. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
   E. Install manual volume dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from

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Air Duct Accessories

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branch takeoff. Install manual volume dampers as indicated on the Drawings and Details, and as necessary to accomplish system air balancing. As a minimum, manual volume dampers will be provided at every divided flow main or branch duct, at every branch duct take off, and every duct extending to individual register, grille, or diffuser. Manual volume dampers are not required upstream of variable volume air terminal units.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.
3. Install remote damper operators for volume dampers located above gypsum board, plaster, and other hard ceilings.
4. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to manufacturer's UL-approved written instructions. Refer to the architectural drawings for fire rating requirements. Provide 1-1/2 hour rated fire dampers for wall and floor assemblies rated for 3 hours or less. Provide 3 hour rated fire dampers for wall and floor assemblies rated for more than 3 hours. Fire dampers will have 165-degree F links except as noted.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
      a. At each change in direction and at maximum 50-foot spacing.
      b. Upstream and downstream from turning vanes.
      c. Upstream or downstream from duct silencers.
      d. Control devices requiring inspection.
      e. Elsewhere as indicated.
   7. Install access doors with swing against duct static pressure.
   8. Access Door Sizes:
      a. One-Hand or Inspection Access: 8 by 5 inches.
      b. Two-Hand Access: 12 by 6 inches.
      c. Head and Hand Access: 18 by 10 inches.
      d. Head and Shoulders Access: 21 by 14 inches.
   9. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

I. Install duct access panel assemblies at locations where greases duct access is required and as indicated on drawings. Label duct access panel assemblies according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access assembly.

J. Install flexible connectors to connect ducts to equipment.
   1. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

K. Installation of Flexible Ducts
1. Install flexible ducts according to the manufacturer’s instructions, applicable SMACNA standards, drawing details, and as follows:
   a. Duct Collars: Provide tap-in collars 4-inches minimum in length with a formed bead 1-inch from the end for attachment of flexible duct. Extend minimum collar length for manual volume dampers.
   b. Connections: Attach flexible duct to the tap-in collars and to sleeves with a duct clamp (draw band) around the inner liner and a second draw band around the insulation jacket. Position duct clamps behind the beads on the collar or sleeve. Duct clamps may be screwed stainless steel bands or nylon straps tightened with a compression tool.
   c. Duct Supports: Support flexible duct at the manufacturer’s recommended interval, but not less than every 5 feet. Maximum permissible sag is 1/2-inch per foot of spacing between supports (maximum of 1-1/4-inches over five feet).
   d. Duct Hangers: Provide hanger straps in contact with the flexible duct at least 2-inch wide so the internal diameter of the duct is not reduced at the point of support.
   e. Duct Bends: Make bends or turns in flexible ducts with not less than a one-duct diameter throat radius.
   f. Connect diffusers, registers, grilles, and light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place. Refer to drawing details for additional requirements.

3.2 FIELD QUALITY CONTROL
A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Install duct test holes where required for testing and balancing purposes.
   6. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION
SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 23 Section “Commissioning of HVAC” also applies to Work of this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. In line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS
A. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS
A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
C. Field quality control test reports.
D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA Certified Ratings Seal.
C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver fans as factory assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer’s written instructions.

C. Lift and support units with manufacturer’s designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Aerovent; a Twin City Fan Company
   3. Ammerman; General Resource Corp.
   4. Carnes Company HVAC.
   5. Cesco.
   7. Ilg.
   8. Loren Cook Company.

B. Description: Direct or belt driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun aluminum, dome top and outlet baffle; square, one piece, aluminum base with venturi inlet cone.
   1. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward inclined blades.

E. Belt Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   4. Fan and motor isolated from exhaust airstream.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2 inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2 inch wood nailer. Size as required to suit roof opening and fan base.
   1. Overall Height: 12 inches.
2.2 IN LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Ammerman; General Resource Corp.
   3. Carnes Company HVAC.
   5. Loren Cook Company.
   6. Penn Ventilation.

B. Description: In line, direct or belt driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

E. Belt Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

G. Accessories:
   1. Variable Speed Controller: Solid state control to reduce speed from 100 to less than 50 percent.
   2. Companion Flanges: For inlet and outlet duct connections.
   3. Fan Guards: 1/2 by 1 inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.3 MOTORS

A. Comply with requirements in Division 23 Section “Common Motor Requirements for HVAC Equipment.”

2.4 SOURCE QUALITY CONTROL


B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, “Laboratory Methods of Testing Fans for Rating.”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Install prefabricated curbs and flashings for each ventilator. Provide fire treated blocking from top of roof deck to the top of the finished roof surface. Provide a level surface for prefab curb mounting.

C. Wash all flashings and counterflashings with acetic acid, and paint with one coat of lead and oil paint, black in color.

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HVAC Power Ventilators

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D. Insulate with 2” thick fiberglass 9 lb. density board between the exhaust duct and its curb.
E. Solder bottom joints and up 2” of side joints of duct under roof ventilator to retain any moisture entering ventilator.
F. Secure roof mounting fans to roof curbs with cadmium plated hardware.
G. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
H. Install units with clearances for service and maintenance.
I. Label units according to requirements specified in Division 23 Section “Identification for HVAC Piping and Equipment.”

3.2 CONNECTIONS
A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section “Air Duct Accessories.”
B. Install ducts adjacent to power ventilators to allow service and maintenance.
C. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”
D. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.3 FIELD QUALITY CONTROL
A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  10. Shut unit down and reconnect automatic temperature control operators.
  11. Remove and replace malfunctioning units and retest as specified above.
B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING
A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Refer to Division 23 Section “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing procedures.
D. Replace fan and motor pulleys as required to achieve design airflow.
E. Lubricate bearings.
3.5 CHECKLIST REQUIREMENTS

A. Installation requirements include the completion of construction checklists for each piece of equipment provided for the project.
   1. Checklist shall be provided to the Contractor by the Commissioning Authority per Division 23 Section “Commissioning of HVAC.”
   2. Model verification of the Checklist shall be completed by the Contractor, as applicable, and submitted with product shop drawings.
   3. Pre-Installation Checks, Installation Checks, and Negative Responses shall be completed by the Contractor, as applicable, as project construction progresses.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Shutoff, single-duct air terminal units.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.
B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan-Powered-Unit Filters: Furnish one spare filter for each filter installed.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.2 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Anemostat Products; a Mestek Company. (www.anemostat.com)
   2. Krueger. (www.krueger-hvac.com)
   3. METALAIRE, Inc. (www.metalaire.com)
   5. Price Industries. (www.price-hvac.com)
   6. Titus. (www.titus-hvac.com)
   7. Trane (www.trane.com)
   8. Tuttle & Bailey. (www.tuttleandbailey.com)

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 0.034-inch steel single wall.
   1. Casing Lining: Adhesive attached, 1/2-inch-thick, polyurethane foam insulation complying with NFPA 90A and UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
   1. Minimum 2-rows.
   2. Where indicated in the equipment schedules

F. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230900 "Instrumentation and Control for HVAC."

G. Capacities and Characteristics
   1. Refer to equipment schedules for capacities and characteristics.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems" and the manufacturers installation instructions.

B. Install air terminal units' level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install return air inlet sound attenuator on fan powered air terminal units.
3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," connect heating coils to return with balancing valve, control valve, shutoff valve, and air vent; and to supply with shutoff valve.
   1. Connect steel heating-coil supply and return piping with union or flange. Copper piping connections do not require unions or flanges.

C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts."

D. Make supply duct connections to fan powered air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels. Label shall be located and sized to be legible from the ceiling access point.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

END OF SECTION
SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Rectangular and square ceiling diffusers.
   2. Louver face diffusers.
   3. Linear bar diffusers.
   4. Linear slot diffusers.
   5. Linear floor diffuser plenums.
   6. Adjustable bar registers.
   7. Fixed face grilles.
   8. Linear bar grilles.

B. Related Sections:
   1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, mounting surface, border, frame, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

B. Source quality-control reports.

1.5 COORDINATION
A. Review the architectural drawings for diffuser, register, and grille mounting surfaces.
PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. METALAIRE, Inc.
      e. Nailor Industries Inc.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.
   2. Face Style: three cones.
   3. Accessories: Refer to the drawings and equipment schedules for accessories.
      a. Equalizing grid.
      b. Plaster ring.

B. Louver Face Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. METALAIRE, Inc.
      c. Nailor Industries Inc.
      d. Price Industries.
      e. Titus.
      f. Tuttle & Bailey.
   2. Accessories: Refer to the drawings and equipment schedules for accessories.
      a. Equalizing grid.
      b. Plaster ring.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. METALAIRE, Inc.
      e. Nailor Industries Inc.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.

B. Linear Slot Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. METALAIRE, Inc.
      e. Nailor Industries Inc.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.
2.3 UNDERFLOOR AIR DISTRIBUTION DIFFUSERS

A. Linear Floor Diffuser Plenums:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. METALAIRE, Inc.
      e. Nailor Industries Inc.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.
   4. Deflection: Zero or 15 degrees. See schedule.
   5. Components:
      a. Aluminum diffuser core.
      b. Diffuser frame.
      c. Plenum, 0.034-inch steel.

2.4 REGISTERS AND GRILLES

A. Adjustable Blade Register:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. METALAIRE, Inc.
      e. Nailor Industries Inc.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.
   2. Frame: Minimum 20 gauge steel.
   4. Damper Type: See schedules.

B. Adjustable Bar Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. METALAIRE, Inc.
      e. Nailor Industries Inc.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.
   2. Frame: Minimum 20 gauge steel.
C. Fixed Face Register:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. Nailor Industries Inc.
      e. Price Industries.
      f. Titus.
      g. Tuttle & Bailey.
   2. Material: Steel
   3. Finish: Baked enamel, white
   4. Face Arrangement: Refer to register schedule.
   5. Core Construction: Refer to register schedule.
   6. Frame: Minimum 20 Gauge Steel.
   7. Mounting Frame: Refer to register schedule.
   8. Mounting: Concealed
   9. Damper Type: Adjustable opposed blade

D. Fixed Face Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. Nailor Industries Inc.
      e. Price Industries.
      f. Titus.
      g. Tuttle & Bailey.
   2. Material: Steel
   3. Finish: Baked enamel, white
   4. Face Arrangement: Refer to grille schedule.
   5. Core Construction: Refer to grille schedule.
   6. Frame: Minimum 20 Gauge Steel.
   7. Mounting: Concealed
   8. Damper Type: Adjustable opposed blade

E. Linear Bar Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Dayus Register & Grille Inc.
      c. Krueger.
      d. Nailor Industries Inc.
      e. Price Industries.
      f. Titus.
      g. Tuttle & Bailey.
   2. Material: Aluminum
   3. Finish: Anodized, color selected by architect
   4. Face Arrangement: Refer to Grille schedule.
   5. Frame: Refer to Grille schedule.
   6. Mounting: Concealed
   7. Damper Type: Adjustable opposed blade

2.5 SOURCE QUALITY CONTROL
A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Provide the appropriate mounting frame or border for each diffuser register or grille location. Verify ceiling grid type for lay-in type inlets and outlets. Non-lay-in diffusers, registers, and grilles will have frames or borders for surface mounting.

3.2 INSTALLATION
A. Diffuser, register, and grille sizes and locations are indicated on the drawings and schedules.
B. Install diffusers, registers, and grilles level and plumb.
C. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
E. Install equalizing grids on round neck ceiling diffusers with an inlet duct of less than one diameter in length.

3.3 ADJUSTING
A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following types of roof mounting intake and relief ventilators:
      1. Louver penthouses.

1.3 PERFORMANCE REQUIREMENTS
   A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of
      gravity loads, wind loads, and thermal movements without permanent deformation of components,
      noise or metal fatigue, or permanent damage to fasteners and anchors.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include
      printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
   B. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and
      ventilator attachments to curbs and curb attachments to roof structure.

1.5 QUALITY ASSURANCE
   A. Source Limitations: Obtain ventilators through one source from a single manufacturer where
      indicated to be of same type, design, or factory applied color finish.

1.6 COORDINATION
   A. Coordinate installation of roof curbs and roof penetrations.

PART 2 - PRODUCTS

2.1 LOUVER PENTHOUSES
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the
      following:
      2. Aerovent; a Twin City Fan company.
      3. Ammerman.
      4. Carnes.
      5. Cesco.
      7. ILG.
      8. Loren Cook Company.
     10. TC Ventco.
   B. Construction: All welded assembly with 6 inch deep louvers, mitered corners, and aluminum
      sheet roof.
C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades.
   1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.

D. Roof Curbs: Galvanized steel sheet; with mitered and welded corners; 1-1/2 inch thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2 inch wood nailer. Size as required to fit roof opening and ventilator base.
   1. Overall Height: 12 inches.

E. Bird Screening: Aluminum, 1/2 inch square mesh, 0.063 inch wire.

F. Insect Screening: Aluminum, 18 by 16 mesh, 0.012 inch wire.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install relief ventilators level, plumb, and at indicated alignment with adjacent work.
   B. Secure relief ventilators to roof curbs with cadmium plated hardware. Use concealed anchorages where possible.
   C. Install relief ventilators with clearances for service and maintenance.
   D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
   E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses.
   F. Label relief ventilators according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
   G. Protect galvanized and nonferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
   H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS
   A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING
   A. Adjust damper linkages for proper damper operation.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 23 Section “Commissioning of HVAC” also applies to Work of this Section.

1.2 SUMMARY
A. Types of condensing units specified in this Section include:
   1. Air cooled condensing units (6 to 120 tons).
B. Related Sections include the following:
   1. Vibration control units are part of this work and are specified in Division 23 Section “Vibration Controls for HVAC Piping and Equipment.”
   2. Concrete bases are part of this work and are specified in Division 23 Section “Common Work Results for HVAC.”

1.3 SUBMITTALS
A. Product Data: For each condensing unit, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
B. Field quality control test reports.
C. Operation and Maintenance Data: For condensing units to include in emergency, operation, and maintenance manuals.
D. Warranty: Special warranty specified in this Section.
E. Equipment Checklist with each piece of equipment. (See Part 3 – Execution)

1.4 QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing units and are based on the specific system indicated.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Fabricate and label refrigeration system according to ASHRAE 15, “Safety Code for Mechanical Refrigeration.”
D. ASHRAE/IESNA 90.1-2013 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6 - “Heating, Ventilating, and Air Conditioning.”
E. ASME Compliance: Fabricate and label water cooled condensing units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

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Packaged Compressor and Condensing Units
C. Coordinate location of piping and electrical rough-ins.

1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Compressor failure.
   b. Condenser coil leak.
2. Warranty Period: Four (4) years from date of Substantial Completion.
3. Warranty Period (Compressor Only): Ten (10) years from date of Substantial Completion.
4. Warranty Period (Condenser Coil Only): Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONDENSING UNITS, AIR COOLED, 6 TO 120 TONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
1. AAON, Inc.
2. Carrier Corporation; Carrier Air Conditioning Div.
3. Lennox Industries Inc.
5. Trane Incorporated.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic or semihermetic compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.
2. Refrigerant Charge: R-410A.

D. Condenser Coil: Seamless copper tube, aluminum fin coil, including subcooling circuit and backseating liquid line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

E. Condenser Fans: Propeller type vertical discharge; either directly or belt driven. Include the following:
   1. Permanently lubricated ball bearing motors.
   2. Separate motor for each fan.
   3. Dynamically and statically balanced fan assemblies.

F. Operating and safety controls include the following:
   1. Manual reset, high pressure cutout switches.
   2. Automatic reset, low pressure cutout switches.
   3. Low oil pressure cutout switch.
   4. Compressor winding thermostat cutout switch.
   5. Three leg, compressor overload protection.
   6. Control transformer.
   7. Magnetic contactors for compressor and condenser fan motors.
   8. Timer to prevent excessive compressor cycling.
G. Accessories:
   1. BACnet Communications interface.
   2. Low Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F with time delay relay to bypass low pressure switch.
   5. Part winding start timing relay, circuit breakers, and contactors.

H. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
   1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer’s standard paint coating.
   2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
   3. Gasketed control panel door.
   4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
   5. Condenser coil hail guard to protect coil from physical damage.

2.2 MOTORS

A. General requirements for motors are specified in Division 23 Section “Common Motor Requirements for HVAC Equipment.”
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate condensing units according to ARI 210/240, ARI 340/360, or ARI 365.

B. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Testing Requirements: Factory test sound power level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of condensing units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer’s recommended clearances.
B. Install roof mounting units on equipment supports specified in Division 07.

C. Vibration Isolation: Mount condensing units on vibration isolators. Vibration isolation devices and installation requirements are specified in Division 23 Section “Vibration Controls for HVAC Piping and Equipment.”

D. Maintain manufacturer’s recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect refrigerant piping to air cooled condensing units; maintain required access to unit. Install furnished field mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section “Refrigerant Piping.”

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform electrical test and visual and mechanical inspection.
   2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

C. Remove and replace malfunctioning condensing units and retest as specified above.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer’s written instructions and perform the following:
   1. Inspect for physical damage to unit casing.
   2. Verify that access doors move freely and are weather tight.
   3. Clean units and inspect for construction debris.
   4. Verify that all bolts and screws are tight.
   5. Adjust vibration isolation and flexible connections.
   6. Verify that controls are connected and operational.

B. Lubricate bearings on fans.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer’s written instructions and complete manufacturer’s startup checklist.

F. Measure and record airflow over coils.

G. Verify proper operation of condenser capacity control device.
H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings and adjust belt tension.

3.6 DEMONSTRATION
A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

3.7 CHECKLIST REQUIREMENTS
A. Installation requirements include the completion of construction checklists for each piece of equipment provided for the project.
   1. Checklist shall be provided to the Contractor by the Commissioning Authority per Division 23 Section “Commissioning of HVAC.”
   2. Model verification of the Checklist shall be completed by the Contractor, as applicable, and submitted with product shop drawings.
   3. Pre-Installation Checks, Installation Checks, and Negative Responses shall be completed by the Contractor, as applicable, as project construction progresses.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 23 Section “Commissioning of HVAC” also applies to Work of this Section.

1.2 SUMMARY

A. This Section includes modular air handling units with coils for indoor installations.

B. Related Sections include the following:
   1. Vibration control units are part of this work and are specified in Division 23 Section “Vibration Controls for HVAC Piping and Equipment.”
   2. Concrete bases are part of this work and are specified in Division 23 Section “Common Work Results for HVAC.”

1.3 SUBMITTALS

A. Product Data: For each type of air handling unit indicated. Include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound power ratings.
   3. Certified coil performance ratings with system operating conditions indicated.
   4. Motor ratings, electrical characteristics, and motor and fan accessories.
   6. Material gages and finishes.
   7. Filters with performance characteristics.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain modular indoor air handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air handling units and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.”

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. NFPA Compliance: Modular indoor air handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, “Installation of Air Conditioning and Ventilating Systems.”

E. ARI Certification: Air handling units and their components shall be factory tested according to ARI 430, “Central Station Air Handling Units,” and shall be listed and labeled by ARI.

F. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier; Div. of United Technologies Corp.
   2. CES Group Inc.; Governair, Mammoth, Temtrol, Venmar Ventrol, Webco Divisions.
   3. Haakon.
   5. Trane Incorporated.

B. NOTE: IF CONTRACTOR SELECTS EQUIPMENT AS MANUFACTURED BY MANUFACTURERS IDENTIFIED AS EQUAL TO THE SCHEDULED BASE MANUFACTURER, CONTRACTOR SHALL BE RESPONSIBLE FOR ACCOUNTING FOR ANY DIFFERENCES IN EQUIPMENT DIMENSIONS, SUPPORTS, WEIGHTS, DUCT AND PIPE CONNECTION SIZES AND LOCATIONS, ARRANGEMENTS, ETC. ALL ADDITIONAL MATERIALS, LABOR, OR COORDINATION WITH OTHER TRADES REQUIRED BY THIS EQUIPMENT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR WITH NO ADDITIONAL COST TO THE OWNER.

2.2 AIR HANDLING UNITS

A. Casings: Provide 2-inch double wall insulated casings for all sections exposed to the air stream. Provide casing panels and/or access doors that are easily and quickly removable for inspection and access to internal parts. Fabricate of channel posts and panels assembled with screws with galvanized steel finish. Provide W-shaped bulb type gasketing between frame channel and panel. Gasketing shall meet UL723 for surface burning characteristics.
   1. Outside casing shall be G90 galvanized steel with frame channel 16 gauge nominal and panel 18 gauge nominal.
   2. Inside casing shall be G90 galvanized steel solid, 20 gauge nominal.
   3. Access doors shall be of galvanized steel construction, flush mounted to cabinetry, with gasketed seal. Provide stainless steel hinges, door latch and handle assembly, and inspection window.

B. Provide single zone units consisting of fan section, coil section, motor, adjustable motor mounting, sheaves and belts rated at 150% of motor horsepower and filter section.

C. Fans shall be airfoil blade design. Fans shall be dynamically balanced before and after installation in fan cabinet section. Maximum fan rpm shall be below the first critical speed fan.
   1. Bearings shall be self aligning, grease lubricated heavy duty pillow block type ball bearings with extended copper lubrication lines to access side of unit. Grease fittings attached to fan base assembly near access door. Bearings shall be selected for minimum average of L-50 life at 100,000 hours in accordance with AFBMA-ANSI Standards.
   2. Locate fan and motor internally on steel base. Factory mount motor on slide base that can be slid out the side of unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on vibration isolators inside cabinetry. Refer to Division 23 Section “Vibration Controls for HVAC Piping and Equipment.”
   3. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil.
   4. V-belt drive shall include cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Provide variable pitch sheaves, matched belts, and drive rated as recommended by manufacturer. Variable and adjustable pitch sheaves shall be selected so required rpm is obtained with sheaves set at mid-position. Standard drive service factor shall be 1.3 times fan brake horsepower.
   5. Motors 1 HP and greater shall be premium efficiency.
   6. Provide shaft grounding system on all motors controlled by variable frequency drives.
D. Provide reinforced points of support for either setting of units.

E. Provide insulated double wall drain pan, located under cooling coil section, extensive enough to catch condensate leaving coil at highest catalogued face velocity. Provide at least one drain connection at low point in drain pan. Drain pans shall be constructed from stainless steel with cross break and pitch to drain connection. Drain connection center line is a minimum of 3” above floor for proper trapping.

F. Cover casing and frame with protective finish on both sides.

G. Hot Hydronic Coils:
   1. General: Provide coils of size, and in locations indicated; and of capacities and performance data as scheduled.
   2. Casing: Provide access to coils from both sides of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Coil connections, vents, and drains shall extend beyond unit casing a minimum of 5”. Coils shall be removable through side panels and/or top panels of unit without removal and disassembly of entire section.
   3. Coils to be ARI certified and UL listed. Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
   4. Fabrication:
      a. Tubes shall be 5/8” OD seamless copper expanded into fins, brazed joints.
      b. Casing shall be formed channel frame of galvanized steel.
      c. Fins shall be aluminum, and shall have a minimum thickness of .012” with full drawn collars. Tubes shall be mechanically expanded into the fins. Bare copper tube shall not be visible between fins. Coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Vent connections shall be provided at the highest point and at the lowest point.
      d. Proof test coils at 315 psi. Leak test coils at 200 psi under water.

H. DX Cooling Coil: An ARI rated UL listed evaporator coil shall be provided with performance parameters as specified in the Schedule. The coil shall be constructed of seamless .020” copper tube primary surface and rippled .008” aluminum plate fin secondary surface. A 304 stainless steel drain pan shall be provided beneath the coil and shall extend past the coil to insure condensate retention. Suction line connections shall be through the side of the unit. Refrigeration distributors are stubbed inside the unit casing. Standard refrigerant shall be R-410A. Coil shall be two circuit type.

I. Provide access sections with double wall access doors with neoprene gaskets, hinges and operable handles from inside and outside of the unit. Provide marine lights, factory installed, factory wired to a common switch and pilot on the exterior of the unit. Wiring shall comply with code. Provide lights in all accessible air handling unit sections.

J. Provide blender sections to provide proper air mixing and distribution of the outside and return airstreams. Proper upstream and downstream spacing shall be provided as recommended by the blender manufacturer. Blenders to be as manufactured by Blender Products and shall be all aluminum construction.

K. Provide return air plenum section provided with top, bottom, side, or end openings as shown for duct attachments. Access door for plenum constructed of galvanized steel and flush mounted. Fabricated with gasketing between door and frame channel, latch and handle assembly factory installed. Standard opening sized to handle up to 1000 ft./mn. through opening.

L. Filter Boxes: Provide filter boxes with hinged access doors at each end. Provide racks to receive filters in angle type pattern.

M. Insulation: Insulate unit casing from air entrance to coils, to air outlet from unit. Insulate framing angles exposed to air stream. Insulation shall be 3 lb./cu. ft. density, neoprene coated, glass fiber insulation. Insulation secured to inner panel with insulation pins. Protect insulation against deterioration from air currents.
1. Insulate drain pans as required to prevent condensate formation on unit exterior at ambient conditions to be encountered. Provide insulation with fire retarding characteristics, complying with NFPA 90A.

N. Air Filters: Provide air filters to fit in unit filter sections of the following type:
   1. 1st Stage: Pleated disposable type air filters 2" thick, 30% efficiency.
   2. 2nd Stage: Cartridge disposable type air filters 4" thick, 90% efficiency.
   3. Filters shall be as manufactured by American Air Filter, Farr, or Cambridge.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
   B. Examine roughing in of hydronic piping systems and electrical services to verify actual locations of connections before installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. General: Install air handling units where indicated, in accordance with equipment manufacturer’s published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
   B. Concrete Bases: Install floor mounting units on 4 inch high concrete bases. See Division 23 Section "Common Work Results for HVAC" for concrete base materials and fabrication requirements.
   C. Arrange installation of units to provide access space around modular indoor air handling units for service and maintenance.
   D. Mounting: Mount fan section only on vibration isolators, in accordance with manufacturer’s instructions. Refer to Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

3.3 CONNECTIONS
   A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   B. Install piping adjacent to machine to allow service and maintenance.
   C. Hydronic Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.
   D. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.
   E. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
   F. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
   G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
H. Tighten electrical connectors and terminals according to manufacturer’s published torque tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

I. All temperature control devices, tubing, wiring, DDC panels, as well as unit motorized intake, return, and exhaust dampers will be furnished under Temperature Control Subcontract. Refer to Division 23 Section “Instrumentation and Control for HVAC.”

3.4 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Leak Test: After installation, fill hydronic coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.

2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.

3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 STARTUP SERVICE

A. Engage a factory authorized service representative to perform startup service.

B. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnect switches.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants.

6. Set face and bypass dampers to full face flow.

7. Set outside and return air mixing dampers to minimum outside air setting.


9. Install clean filters.

10. Verify that manual and automatic control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for modular indoor air handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel.

3.6 CLEANING

A. Clean modular indoor air handling units internally, on completion of installation, according to manufacturer’s written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air handling and air distribution systems, clean filter housings and install new filters.
3.7 DEMONSTRATION
A. Engage a factory authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain modular indoor air handling units. Refer to Division 01 Section “Demonstration and Training.”

3.8 CHECKLIST REQUIREMENTS
A. Installation requirements include the completion of construction checklists for each piece of equipment provided for the project.
   1. Checklist shall be provided to the Contractor by the Commissioning Authority per Division 23 Section “Commissioning of HVAC.”
   2. Model verification of the Checklist shall be completed by the Contractor, as applicable, and submitted with product shop drawings.
   3. Pre-Installation Checks, Installation Checks, and Negative Responses shall be completed by the Contractor, as applicable, as project construction progresses.
   4. Refer to the following Checklist.
B. Sample Checklist (attached).
### AIR HANDLING UNIT CHECKLIST
TAG ID:________

1. **AHU Model Verification**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Specified</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Flow, CFM Design / Minimum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Capacity, gpm / MBH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating Capacity, gpm / MBH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volts / Ph / A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. **Pre-Installation Checks**

The following must be completed upon delivery of equipment to the worksite. Prior to installation, the information must be verified by an Owner’s Representative (O.R.).

<table>
<thead>
<tr>
<th>2A Physical Checks</th>
<th>Contractor</th>
<th>Initials</th>
<th>O.R.</th>
<th>Mechanical</th>
</tr>
</thead>
<tbody>
<tr>
<td>The AHU is free of physical damage</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The air openings to the AHU are sealed with durable plastic</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The water openings are sealed with plastic plugs</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The AHU appears to be free of water damage</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All access door latches are operable</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each access door is full height and removable</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All components (mixing box, coils, access, fan, etc) are present and in the proper order</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation and startup manual in checklist envelope</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit tags affixed</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjacent floor drains are ready for use</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2B Component Verification</th>
<th>Contractor</th>
<th>Initials</th>
<th>O.R.</th>
<th>Mechanical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of rows in heating coil, design/actual</td>
<td>/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The heating coil surface area is free of damage</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rows in cooling coil, design/actual</td>
<td>/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling coil surface area is free of damage</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return and outdoor air damper properly sized and seals aligned</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan horsepower, design/actual</td>
<td>/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan voltage, design/actual</td>
<td>/</td>
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<td></td>
<td></td>
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<tr>
<td>Fan efficiency, design/actual</td>
<td>/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer’s ratings are readable and accurate</td>
<td>Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. **Installation and Startup**

The following items need to be verified during installation. Fill in blanks with check, specific information, or circle “yes” or “no”. For any negative responses, complete Section 4.

<table>
<thead>
<tr>
<th>3A</th>
<th>Concrete pad</th>
<th>Contractor</th>
<th>Initials</th>
<th>CxA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Location and dimensions of pad verified</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proper clearances around pad verified with MC</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concrete pad dimensions, design / actual</td>
<td>Length:</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Width:</td>
<td>/</td>
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<tr>
<td></td>
<td></td>
<td>Height:</td>
<td>/</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3B</th>
<th>Installation of AHU</th>
<th>Contractor</th>
<th>Initials</th>
<th>CxA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit secured as required in specifications</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate clearance around box</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>__ inches on access side of AHU</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>__ inches on back side of AHU</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>__ inches on top of AHU</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>__ inches available for outdoor air ductwork</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>__ inches available for supply air duct (Y duct diameters)</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>__ inches for coil pull space</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling coil drain pan properly draining</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internal vibration isolators in good condition</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Each fan motor has a minimum of 2 drive belts</td>
<td>Yes / No</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Protective shrouds for belts in place and secure</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extended grease lubrication lines installed for each fan</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metal to metal connections eliminated to prevent noise/vibration problems</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gaskets installed on all four edges of each access door</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All filter frames are gasketed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit properly labeled (easy to see)</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All shipping and installation materials are removed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3C</td>
<td><strong>Coils and piping</strong></td>
<td>Contractor</td>
<td>Initials</td>
<td>CxA</td>
</tr>
<tr>
<td>----</td>
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</tr>
<tr>
<td></td>
<td>Flanges or unions for coil removal</td>
<td>Mechanical</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air vents for each coil are installed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coil drain valves installed for each coil</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/4” capped drain valves on each coil drain</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit drain minimum of 1 1/2” installed and trapped</td>
<td>Yes / No</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Unit drain line insulated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply connection and counterflows on each coil</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply shut off valves on each coil are installed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Return balancing valve installed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control valves installed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concentric reducers used in and out of control valve</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strainer installed ahead of control valve</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gauge cocks installed, each coil supply and return</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valve tags affixed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piping is adequately supported</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pipe labeling is affixed, with correct flow directions indicated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insulation is installed and free of defects</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insulation at strainer is removable at blowoff</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fins are combed out on each coil</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All components easily accessible</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermometers and pressure gauges on supply and return</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Condensate piping properly installed (secured, trapped, to a drain)</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ductwork</td>
<td>Mechanical</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vibration isolators installed in return and outdoor air ducts</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y duct diameters of straight discharge supply duct available (or vibration isolators installed prior to supply duct leaving equip room)</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All dampers / sensors are accessible</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rubber/plastic sealant and protector for sensors pipes or wire through metal sheets in duct or air handling unit walls installed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All dampers stroke fully and easily</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All dampers close tightly</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate locations available for balancing unit</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Record drawings accurate</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outdoor/return air arrangement will prevent frozen coil</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ductwork labeling is affixed, with correct flow directions indicated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3E</td>
<td>Electrical</td>
<td>Contractor</td>
<td>Initials</td>
<td>CxA</td>
</tr>
<tr>
<td>----</td>
<td>------------</td>
<td>------------</td>
<td>----------</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>Local disconnect installed in accessible location</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Motor rotation in the proper direction</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All electrical connections are tight</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proper grounding installed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3F</th>
<th>Controls – Installation</th>
<th>Controls</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control panel accessible and labeled properly</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature sensors installed (RA, OA, CC, HC, SA) and calibrated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure drop gauges are installed across each filter and calibrated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fan DP sensor installed and calibrated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fan pitch controls installed and calibrated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Return air CO₂ sensor installed and calibrated</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rubber/plastic sealant and protector for sensors pipes or wire through metal sheets in duct or air handling unit walls installed</td>
<td>Yes / No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smoke detectors installed in proper locations and functioning</td>
<td>Yes / No</td>
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<td>Dampers installed and calibrated</td>
<td>Yes / No</td>
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<td>Hot / chilled water actuators installed and calibrated</td>
<td>Yes / No</td>
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<td>Duct static pressure sensor installed and calibrated</td>
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<td>Safety items installed (freeze, high pressure, motor overload)</td>
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<td>Communication with central system functioning</td>
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<td>Internal isolators free to move</td>
<td>Yes / No</td>
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<td>Alignment of motor driven components correct</td>
<td>Yes / No</td>
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<td>System starts and runs without any unusual noise and vibration</td>
<td>Yes / No</td>
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<td>Manufacturer's startup checklist completed and attached</td>
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<td>Fan lubricated and aligned</td>
<td>Yes / No</td>
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<td>All filters installed properly (no bypass air) and are clean</td>
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<td>VAV box dampers manually opened or are controllable</td>
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<td>Vibration isolation inspection report complete (attach)</td>
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<td>VFD verification checklist completed</td>
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<td>Fan motor amps, design / actual</td>
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<td>System discharge static pressure, design / actual</td>
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<td>Heating sequence of control correct (should be attached)</td>
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<td>Cool down sequence of control correct (should be attached)</td>
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<td>IAQ override sequence of control correct (should be attached)</td>
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<td>Unoccupied sequence of control correct (should be attached)</td>
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<td>Safety items physically tested (freeze, high pressure, motor overload)</td>
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<tr>
<td>Fan rotation proper direction</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>Fan belts have proper tension and are in acceptable condition</td>
<td>Yes / No</td>
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<td>Fan noise level is acceptable</td>
<td>Yes / No</td>
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<tr>
<td>Fan area is clean</td>
<td>Yes / No</td>
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<tr>
<td>Motor volts, design / actual</td>
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<td>Motor amps, design / actual</td>
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<td>Motor hp, design / actual</td>
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<tr>
<td>Fan speed, design / actual (rpm)</td>
<td>/</td>
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<tr>
<td>Coils are clean and in good condition</td>
<td>Yes / No</td>
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<tr>
<td>Heating coil air pressure drop at full flow, design / actual (in H2O)</td>
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<td>Heating coil water flow, design / actual (gpm)</td>
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<td>Heating coil water pressure drop, design / actual (ft)</td>
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<td>Cooling coil air pressure drop</td>
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<tr>
<td>Construction filters are removed</td>
<td>Yes / No</td>
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<td>Filters are clean and tight fitting</td>
<td>Yes / No</td>
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<td>Air filter pressure drop, design / actual</td>
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<tr>
<td>All doors properly seal</td>
<td>Yes / No</td>
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<td>Minimum outdoor air constant at all system flows</td>
<td>Yes / No</td>
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4. **Negative Responses** (attach sheets as necessary)

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**END OF SECTION**
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.
B. Do not use cabinet unit heaters with electric-resistance heating coils.

1.3 DEFINITIONS
A. BAS: Building automation system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   6. Indicate location and arrangement of piping valves and specialties.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which cabinet unit heaters will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
   6. Perimeter moldings for exposed or partially exposed cabinets.
B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Airtherm; a Mestek company.
   3. Daikin
   4. Ritting
   5. Sterling
   6. Trane Incorporated

2.2 DESCRIPTION
A. Factory-assembled and -tested unit complying with AHRI 440.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS
A. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 COIL SECTION INSULATION
A. Insulation Materials: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
   1. Thickness: 1/2 inch.
   2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
   3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
   4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS
A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
   1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
   2. Recessed Flanges: Steel, finished to match cabinet.
   3. Control Access Door: Key operated.
   4. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.
   5. Extended Piping Compartment: 8-inch-wide piping end pocket.
   6. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.
2.6 FILTERS
   A. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
      1. Pleated: 90 percent arrestance and MERV 7.

2.7 COILS
   A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

2.8 CONTROLS
   A. Fan and Motor Board: Removable.
      1. Fan: Forward curved, high static, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
      3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
   B. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls."
   C. Basic Unit Controls:
   D. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.9 CAPACITIES AND CHARACTERISTICS
   A. Refer to the Cabinet Unit Heater Schedule on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install cabinet unit heaters to comply with NFPA 90A.
   B. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS
   A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," Drawings indicate general arrangement of piping, fittings, and specialties.
   B. For concealed cabinet unit heaters connect supply and return ducts to cabinet unit heaters with
C. Comply with safety requirements in UL 1995.

D. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

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SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Common electrical installation requirements.
   3. Demolition.
   4. Cutting and patching for electrical construction.
   5. Touchup painting.
   6. Disposition of existing materials and equipment.

1.2 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.
C. Comply with State and/or City Code requirements.
D. All materials shall meet the standards of the following institutes where applicable:
   1. National Fire Protection Association (NFPA)
   2. American Society of Testing Materials (ASTM)
   3. American National Standards Institute (ANSI)
   4. National Electrical Manufacturer’s Association (NEMA)
   5. Institute of Electrical and Electronic Engineers (IEEE)

1.3 COORDINATION
A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 "Access Doors and Panels."
D. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078400 "Firestopping."
E. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
2. Core drilling through post-tensioned slab: The existing post-tensioned slabs contain post-tensioned tendons that must not be damaged or broken. No nailing, drilling, cutting or other disruption to the slab is allowed without prior written approval by the structural engineer. Contractor shall positively locate the existing tendons and submit to the structural engineer for approval a written procedure, including plans showing existing tendon locations and proposed disruption of the slab.

F. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

G. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.4 DRAWINGS
A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. All devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.5 EQUIPMENT REQUIRING ELECTRICAL SERVICE
A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service.

B. Drawings indicate design loads, voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the owner. Such adjustment shall be subject to the review of the Architect.

C. Incidental items not indicated on Drawing or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide complete system, shall be furnished and installed though not itemized here in detail.

1.6 SITE INVESTIGATION
A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.
1.7 EQUIVALENTS AND SUBSTITUTIONS

A. The applicable paragraphs for General Requirements, Division 01 apply herein.

B. Basis of Design: The manufacturer’s name and product listed on the drawings, or listed first of several names in these Specifications, is used as a basis for design to establish space requirements, a standard of quality and performance.

C. Equivalents: Products of one or more other manufacturer’s names listed in these Specifications following the words “or equivalent by” may be selected, subject to paragraph below titled “Contractor’s Responsibility for Equivalent and Substitutions”.

D. Other Options:
   1. For products specified by naming only one manufacturer, refer to paragraph below under “Substitutions”.
   2. For products specified only by performance characteristics or reference standards, select any manufacturer meeting the requirements.

E. Substitutions: Requests for acceptance of a product of manufacturer’s name not listed in these Specifications will be considered if any one of the following conditions is met:
   1. The named product is not available because of strikes or discontinuance of manufacture; and the proposed product is equivalent to the named product.
   2. The proposed product is superior to the named product, in the opinion of the Owner’s Representative.
   3. The proposed product is equivalent to the named product and its use will be to the advantage of the Owner, by the Owner receiving an equitable credit or cost savings. The Owner’s Representative reserves the right to reject any substitution.
   4. Submit proposed substitutions with bid along with alternate price, complete descriptive data and a comparison of the substitute manufacturer’s product with specified product. Request for acceptance of a product of manufacturer’s name not listed in these Specifications, is subject to the paragraph titled “Contractor’s Responsibility Equivalents and Substitutions”.

F. Contractor’s Responsibility for Equivalents and Substitutions:
   1. Items submitted as a substitution to the Basis of Design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:
      b. Contract time adjustment.
      c. Item by item breakdown of differences between Basis of Design and substituted item.
      d. Operation, maintenance and energy cost difference.
   2. Products of manufacturer must match the features, construction, performance and size of those selected for design. Standard catalogued may require certain modifications to meet specified requirements.
   3. The responsibility for providing that specified requirements have been met remains with the manufacturer and Contractor. Should the substituted item fail to perform in accordance with the Specifications, replace same with the originally specified item without extra cost to the contract.
   4. When requesting review of an equivalent or substituted product, submit a comparison chart listing features, construction, performance and sizes of name product versus equivalent or substituted product.
   5. Submittals for review of an equivalent or substituted product will be reviewed for acceptability when all the above requirements have been met. Contractor shall be responsible for all costs incurred by the Architect and Engineer for review of equivalency beyond initial review.
   6. Coordinate the installation of the product with all trades.
   7. Contractor shall be responsible for changes in electric wiring, materials and for all other additional costs of construction by all trades involved to accommodate the product to perform the same as the product used in the “Basis of Design”.

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Common Work Results for Electrical

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8. Coordination of General Equivalents and Substitutions: Where Contract Documents permits selection from general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with other work.

9. Provide necessary additional items so that selected or substituted item operates equivalent to the Basis of Design and properly fits in the available space allocated for the Basis of Design.

10. Contractor is responsible for assuring that piping, conduit, duct, flue and other service locations for general equivalents or substitutions do not cause access, service or operational difficulties any greater than would be encountered with the Basis of Design.

11. Failure to comply with these requirements will result in immediate rejection of the request for substitution.

1.8 GENERAL SUBMITTAL REQUIREMENTS

A. Refer to Division 01 for additional requirements.

B. Coordination and Sequencing:
   1. Coordinate submittals 3 weeks (minimum) prior to expected order date so that work will not be delayed by submittals.
   2. Do not submit product data, or allow its use on the project until compliance with requirement of Contract Documents has been confirmed by Contractor.
   3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
   4. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, building automation and temperature control, and test and balance subcontractors.
   5. Make submittals for group of similar products or materials or by area of work complete and at one time, not in piecemeal fashion.
   6. Identify submittals with Architect’s project name and number, with item designation as indicated on drawings, and referenced to applicable paragraphs of the specifications. Submit in brochure form.
   7. Submittals of products needed to start of Project for its installation, or those requiring a long lead time for assembly or manufacturing, should be submitted before the others.

C. Preparations of Submittals:
   1. Refer to Division 01 requirements.
   2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
   3. Indicate any portions of work, which deviate from the Contract Documents.
      a. Explain the reasons for the deviations.
      b. Show how such deviations coordinate with interfacing portions of other work.
   4. Show Contractor’s executed review and approval marking.
   5. Provide space for the Owner’s Representative “Action” marking.
   6. Submittals, which are received from sources other than through Contractor’s office, will be returned “Without Action”.
   7. Submittals shall be presented in a neat and legible fashion and shall be returned “Without Action” if presented in any other fashion.

D. Response to Submittals: Where standard product data has been submitted, it is recognized:
   1. That the Submitter has determined that the products fulfill the specified requirements.
   2. That the submittal is for the Owner’s Representative information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

E. If more than two submittals (either for shop drawings, or test reports) are made by the Contractor due to the incompletion, non-compliance, errors, omissions, etc. the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.
1.9 RECORD DRAWINGS

A. Record drawings shall meet all "As-built" and "Record Drawings" requirements for <insert name of client or facility>. Coordinate all requirements with Hennepin County staff prior to completion.

B. Drawings:
   1. Record of Project progress: Maintain drawings available at the job site for inspection. Keep an accurate, legible and continuously updated record of installed locations and all project revisions other than revised drawings issued by the Architect, including source and date of authorization. Utilize only contract drawing symbols for recording the work. Drawing notations to be sufficiently clear in the representation of the work, for utilization by a CADD operator (drafts person) who is not necessarily familiar with the installed work.
   2. Record of Installation: At the conclusion of the work, deliver one (1) set of updated drawings to the Owner's Representative for review. Following the review, Contractor shall have incorporated by a competent CADD operator all of the installed data represented on the project progress drawings.
   3. Include in Record Drawings the Following:
      a. Revisions, including sketches, bulletins, change orders, written addenda and directives, clarifications and responses generated by requests for information (RFIs), regardless of source of the revision.
      b. Location and configuration of equipment with related housekeeping pads.
      c. Physical routing of raceways, exposed and above ceilings with locations of fire dampers, combination fire/smoke dampers, smoke detectors, power supplies, etc., plainly marked and identified.
      d. Location of room controllers, switches, devices, and sensors.
      e. Physical routing of raceways exposed and above ceiling with locations of accessories, pull points, access points plainly marked and identified.
      f. Location of wall and ceiling access panels.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078400 "Firestopping."
3.3 DEMOLITION
A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
B. Reroute circuits as required to serve equipment not in the demolition area.
C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
D. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
E. Remove demolished material from Project site.
F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.
H. Assume that all existing equipment and fixtures indicated to be reused are in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling.
I. Fixtures and other equipment removed and to be used shall be cleaned before reinstallation. Provide new lamps for reused light fixtures.
J. Added Circuits: All loads and circuits added to existing panelboards shall be balanced between phases. On existing panelboards where circuits are changed, replace panel directories with new typed directories.
K. All material and equipment which is noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the owner and stored where directed on the site.
L. Remove all abandoned low voltage wiring. All wiring disconnected on one or both ends is considered abandoned unless tagged and labeled “future” or “spare”. Verify with Owner any cabling connected on both ends is still in use prior to removal.

3.4 CUTTING AND PATCHING
A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.5 FIELD QUALITY CONTROL
A. Inspect installed components for damage and faulty work, including the following:
   1. Firestopping.
   2. Electrical demolition.
   3. Cutting and patching for electrical construction.
   4. Touchup painting.
3.6 REFINISHING AND TOUCHUP PAINTING
A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000 "Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION
A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.8 DISPOSITION OF EXISTING BALLASTS
A. Environmental Protection Agency (EPA) Regulations and Minnesota Pollution Control Agency (MPCA) Rules require controlled disposal of ballasts containing polychlorinated bi-phenyls (PCBs) when removed from service. The ballasts involved were generally manufactured between 1950 and 1979.
B. Provide suitable ballast collection containers at the project site. Check the ballasts in all fixtures removed from service under this contract. Containers shall be boxes constructed of heavy-duty cardboard with closed tops and packed to a maximum of 40 pounds each. Some ballasts may be labeled to indicate whether they do or do not contain PCBs. Remove from the fixtures ballasts known or assumed to contain PCBs and place them in designated PCB ballast collection containers. Remove from the fixtures known to not contain PCBs and place them in designated non-PCB ballast collection containers.
C. Turn ballasts over to Hennepin County for disposal.

3.9 DISPOSITION OF EXISTING FLUORESCENT LAMPS
A. EPA Regulations and Minnesota Pollution Control Agency (MPCA) rules require the controlled disposal of fluorescent lamps.
B. Remove all existing fluorescent lamps and package to prevent breakage according to EPA Regulations. Place the lamps in 4-foot fiberboard drums, typical in the industry for lamp recycling.
C. Furnish the Owner with a record for these lamps, indicating the number of lamps, time and location of turnover.
D. Turn lamps over the Hennepin County for recycling.

3.10 ELECTRIC SERVICE OUTAGE AND ENERGIZATIONS
A. Owner Approval: Electric service outages or energizations required shall be approved by the Owner before outages or energization. Outages shall be scheduled at the convenience of the Owner.
B. Written Request: Requests for outages and energizations shall be submitted in writing to the Owner for approval at the earliest possible date and in no case later than 14 days prior to the outage and/or energization.
C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours' notice has been given by the Owner.

D. Schedules: A minimum of two (2) weeks before the first outage, submit a schedule of proposed sequence of all the electric feeder and switchboard outages and energizations. This schedule shall show construction energizations and shall include any weekend work. The schedule shall list the work to be completed during and between each outage.

E. Minimize all outages on the Owner's electrical system and employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary.

F. Before submitting any energization and/or outage requests, provide the owner with evidence that the following requirements have been met:
   1. All required equipment and material is on the job site. All related installations that can be worked on without an energization and/or outage are complete, tested, available for inspection, and ready for service.
   2. All shop drawings, test reports, installation data, and operational data have been submitted and approved.
   3. The energizing and outage schedule has been submitted and approved.

G. Similar outage procedures shall be followed for telecommunications and other services to the facility.

END OF SECTION
SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Copper building wire rated 600 V or less.
   2. Aluminum building wire rated 600 V or less.
   3. Metal-clad cable, Type MC, rated 600 V or less.
   4. Armored cable, Type AC, rated 600 V or less.
   5. Connectors, splices, and terminations rated 600 V and less.
B. Related Requirements:
   1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
   2. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
   3. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.2 DEFINITIONS
A. RoHS: Restriction of Hazardous Substances.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency.
B. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 PRODUCTS

2.1 COPPER BUILDING WIRE
A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alanwire
   2. Alpha Wire.
   3. American Bare Conductor
   4. Belden Inc.
   5. Cerro Wire
   7. General Cable Technologies Corporation.
8. Okonite Company (The)
10. Southwire Incorporated.
11. United Copper Industries.

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:
1. Type THHN and Type THWN-2: Comply with UL 83.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems.
2. Allied.
3. Anixter
4. Kaf-Tech
5. Service Wire Co.

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:
1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel, interlocked.

2.3 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems.
   2. Allied.
   3. Anixter
   4. Kaf-Tech
   5. Okonite Company (The)
   7. Southwire Incorporated.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

H. Armor: Steel, interlocked.

2.4 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. 3M Electrical Products
   2. AFC Cable Systems, Inc.
   5. Ideal Industries, Inc.
   6. ILSCO
   7. NSI Industries LLC.
   8. O-Z/Gedney; a brand of the EGS Electrical Group.
   10. TE Connectivity Ltd.
   11. Thomas & Betts Corporation

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Copper.
   2. Type: One hole with standard barrels.
   3. Termination: Compression.
PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.


3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

H. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

J. Final Connections to Light Fixtures, Motors, and Vibrating Equipment: MC or AC – this is the only approved installation for these cable types. Use weathertight versions in exterior applications.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

H. Group conductors with phases A, B, C, and neutral together in conduits or raceways regardless of number of sets of conductors, conduits or raceway type.

I. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings. Where the quantity of wires is not indicated on the drawings for branch circuits (2) #12 copper conductors shall be provided.

J. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings. The minimum size of emergency systems conductors shall be No. 10 AWG. 60 deg. C ampacities shall be used for sizing wire and cable for feeders rated 100 amps and below. 75 deg. C ampacities shall be used for sizing of all wire and cable for feeders rated over 100 amps. This sizing requirement applies to all cables in these size ranges, including those with higher insulation ratings. Use No. 10 AWG for conductors in 120 volt 20 amp branch circuits longer than 100 feet (80 m), and in 277 volt 20 amp branch circuits longer than 200 feet (160 m).

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

D. Stranded conductors shall have termination device crimped onto conductors prior to connection to outlet devices or installed with back-wired devices listed for stranded.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
3. Perform each of the following visual and electrical tests:
   a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
   b. Test bolted connections for high resistance using one of the following:
      1) A low-resistance ohmmeter.
      2) Calibrated torque wrench.
      3) Thermographic survey.
   c. Inspect compression-applied connectors for correct cable match and indentation.
   d. Inspect for correct identification.
   e. Inspect cable jacket and condition.
   f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
   g. Continuity test on each conductor and cable.
   h. Uniform resistance of parallel conductors.

4. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Test and Inspection Reports: Prepare a written report to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency and testing agency's field supervisor.
B. Field quality-control reports.

1.4 QUALITY ASSURANCE
A. Testing Agency Qualifications: Certified by NETA.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alanwire
   2. Burndy; Part of Hubbell Electrical Systems.
   3. Dossert; AFL Telecommunications LLC.
   4. ERICO International Corporation.
   5. Fushi Copperweld Inc.
   6. Galvan Industries, Inc.; Electrical Products Division, LLC.
   8. ILSCO.
   10. Robbins Lightning, Inc.
   12. Thomas & Betts, a Member of the ABB Group.

2.2 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alanwire
   2. Cerrowire
3. General Cable Technologies Corporation.
5. United Copper Industries.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.

D. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

E. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

F. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 GROUNDING SEPARATELY DERIVED SYSTEMS
   A. Transformer: Ground the secondary side of transformers to establish separately derived system.
      Size ground conductor as indicated or per NFPA 70.

3.3 EQUIPMENT GROUNDING
   A. Install insulated equipment grounding conductors with all feeders and branch circuits.
   B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted
electrical devices operating at 120 V and more, including air cleaners, heaters, dampers,
humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and
connected metallic piping.
   C. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment
grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to
heater units, piping, connected equipment, and components.
   D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor
connected to the receptacle grounding terminal. Isolate conductor from raceway and from
panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the
applicable derived system or service unless otherwise indicated.
   E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or
feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting
listed for the purpose. Install fitting where raceway enters enclosure, and install a separate
insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard
grounding terminals. Terminate at equipment grounding conductor terminal of the applicable
derived system or service unless otherwise indicated.

3.4 INSTALLATION
   A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise
indicated or required by Code. Avoid obstructing access or placing conductors where they may be
subjected to strain, impact, or damage.
   B. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of
associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond
across flexible duct connections to achieve continuity.
   C. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select
connectors, connection hardware, conductors, and connection methods so metals in direct contact
are galvanically compatible.
      1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make
contact points closer in order of galvanic series.
      2. Make connections with clean, bare metal at points of contact.
      3. Coat and seal connections having dissimilar metals with inert material to prevent future
penetration of moisture to contact surfaces.

3.5 FIELD QUALITY CONTROL
   A. Perform tests and inspections.
   B. Tests and Inspections:
      1. After installing grounding system but before permanent electrical circuits have been energized,
test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer’s written instructions.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION
SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Slotted support systems, hardware, and accessories.
      b. Clamps.
      c. Hangers.
      d. Sockets.
      e. Eye nuts.
      f. Fasteners.
      g. Anchors.
      h. Saddles.
      i. Brackets.
   2. Include rated capacities and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Ductwork, piping, fittings, and supports.
   3. Structural members to which hangers and supports will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Projectors.

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Allied Tube & Conduit; Cooper B-Line, Inc.; a division of Cooper Industries.
   b. ERICO International Corporation.
   c. GS Metals Corp.
   d. Thomas & Betts Corporation.
   e. Unistrut; Tyco International, Ltd.
   f. Wesanco, Inc.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.


5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.

C. Comply with MFMA-4 factory-fabricated components for field assembly.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cooper Industries.
      b. Flex-Strut, Inc.
      c. Haydon Corporation
      d. MKT Metal Manufacturing
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
   2. Channel Width: 1-5/8 inches (41.25 mm).

D. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least one surface.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allied Tube & Conduit.
      b. B-Line, Inc.
      c. Fabco Plastics
      d. G-Strut
      e. Haydon Corporation
      f. Seasafe, Inc
   2. Channel Width: 1-5/8 inches (41.25 mm).
   3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
   4. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
   5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

E. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


PART 3 EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

B. NECA 1.

C. NECA 101

D. NECA 102.

E. NECA 105.

F. NECA 111.

G. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

H. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

I. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
1. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

2. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

J. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION
A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
   6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 or Spring-tension clamps.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 PAINTING
A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
1. Metal conduits, tubing, and fittings.
2. Metal wireways and auxiliary gutters.
3. Nonmetal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
B. Related Requirements:
1. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.2 DEFINITIONS
A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.3 ACTION SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
B. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS AND FITTINGS
A. Metal Conduit:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AFC Cable Systems, Inc.
   b. Allied Tube & Conduit; a Tyco International Ltd. Co.
   c. Anamet Electrical, Inc.
   d. Calconduit
   e. Electri-Flex Company.
f. FSR Inc.  
g. Korkap  
h. Opti-Com Manufacturing Network, Inc.  
i. O-Z/Gedney; a brand of EGS Electrical Group.  
j. Perma-Cote  
k. Picoma Industries, Inc.  
l. Plasti-Bond  
m. Republic Conduit.  
n. Robroy Industries.  
o. Southwire Company.  
p. Thomas & Betts Corporation.  
q. Western Tube and Conduit Corporation.  
r. Wheatland Tube Company; a division of John Maneely Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AFC Cable Systems, Inc.
   b. Allied Tube & Conduit; a Tyco International Ltd. Co.
   c. Anamet Electrical, Inc.
   d. Bridgeport Fittings, Inc.
   e. Calconduit
   f. Electri-Flex Company.
   g. FSR Inc.
   h. Opti-Com Manufacturing Network, Inc.
   i. O-Z/Gedney; a brand of EGS Electrical Group.
   j. Perma-Cote
   k. Picoma Industries, Inc.
   l. Plasti-Bond
   m. Republic Conduit.
   n. Robroy Industries.
   o. Southwire Company.
   p. Thomas & Betts Corporation.
   q. Topaz Electric; a division of Topaz Lighting Corp.
   r. Western Tube and Conduit Corporation.
   s. Wheatland Tube Company; a division of John Maneely Company.

2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Fittings for EMT:
   a. Material: Steel or Zinc die cast.
   b. Type: Setscrew or compression.
6. EMT Fittings Materials:
   a. All Zinc materials shall be ASTM B86 certified
   b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
   c. All Steel shall be SAE 1050.
7. EMT Fittings Design:
   a. Zinc die cast components shall be ball burnished.
   b. Steel parts shall be zinc plated for corrosion protection.
   c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
   d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
   e. All fitting throat diameters shall be smooth with no sharp edges or slag.
   f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
   g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.

8. Transition Fittings:
   a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one raceway type to another must be UL listed for that application.

9. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. B-Line, an Eaton business
   2. Hoffman; a Pentair company.
   4. Square D; a brand of Schneider Electric.
B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
D. Wireway Covers: Hinged type unless otherwise indicated.
E. Finish: Manufacturer's standard enamel finish.

2.3 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Allied Moulded Products, Inc.
   2. Hoffman; a Pentair company.
   3. Lamson & Sessions; Carlon Electrical Products.
   4. Niedax Inc.
B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Hubbell Incorporated; Wiring Device-Kellems
   b. Mono-Systems, Inc.
   c. Panduit Corp.
   d. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer’s standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Hubbell Incorporated; Wiring Device-Kellems
   b. Mono-Systems, Inc.
   c. Panduit Corp.
   d. Wiremold / Legrand.

D. Tele-Power Poles:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Mono-Systems, Inc.
   b. Panduit Corp.
   c. Wiremold / Legrand.


3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adalet.
2. Crouse-Hinds, an Eaton business
3. EGS/Appleton Electric.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
10. Mono-Systems, Inc.
12. Plasti-Bond
13. RACO; a Hubbell Company.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
17. Topaz Electric; a division of Topaz Lighting
18. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed

E. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable, round.
   1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
   1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

M. Gangable boxes are prohibited.

N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

O. Cabinets:
   1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC or IMC.
   2. Concealed Conduit, Aboveground: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: GRC or IMC.
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression, steel or Zinc die-cast metal fittings. Comply with NEMA FB 2.10 and UL514B.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Do not install horizontal raceway runs above water and steam piping.
C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Raceways Within 1 ½“ of Roof Deck:
   1. All raceway shall be installed further from 1 ½“ of roof deck or raceway shall be RMC or IMC.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for [recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.]
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a rain-tight connection between box and cover plate or supported equipment and box.

X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Do not install boxes back-to-back.

Y. Locate boxes so that cover or plate will not span different building finishes.

Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

DD. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

EE. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

FF. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

GG. Set outlet boxes for flush mounted devices to within 1/8” of finished wall.

HH. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8” of finished wall.

II. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION
SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 SLEEVES
A. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

B. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

C. STI EZ-Path enclosed fire-rated device, containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to adjust, remove, or reinstall firestop materials. The pathway shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
   1. Series 22: 1.5 inches (38 mm) high x 1.5 inches (38 mm) wide x 10.5 inches (267 mm) long, volume expansion of fire seal 40 times, inserts into 2 inch (51 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 25 CAT5 cables.
   2. Series 33: 3.0 inches (76 mm) high x 3.0 inches (76 mm) wide x 10.5 inches (267 mm) long, volume expansion of fire seal 16 times, inserts into 4 inch (102 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 120 CAT5 cables, up to seven can be ganged together, can be lengthened in 6 inch (152 mm) increments, attaches to a 4 inch (102 mm) conduit, rated for up to 4 hours installed in floor.
   3. Series 44: 4 inches (102 mm) high x 4 5/8 inches (118 mm) wide x 14 inches (356 mm) long, volume expansion of fire seal 16 times, inserts into 6 inch (153 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 244 CAT5 cables, up to five can be ganged together in walls, up to 16 can be ganged together in floors, rated for up to 4 hours installed in floor.
   4. Approved Equals: Hilti, Metacaulk
2.2 SILICONE SEALANTS
A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS
A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.
H. All cable bundles shall utilize an enclosed fire rated pathway device whenever said cables penetrate rated walls.

END OF SECTION
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Labels.
   2. Tapes and stencils.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Comply with NFPA 70.
B. Comply with NFPA 70E and Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.
C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS
A. Raceways and Cables Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.
B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded branch-circuit conductors.
   1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
   3. Colors for 480/277-V Circuits:
      b. Phase B: Orange.
      c. Phase C: Yellow.
   6. Colors for Isolated Grounds: Green with white stripe.
C. Warning labels and signs shall include, but are not limited to, the following legends:
   1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
2.3 TAPES AND STENCILS
A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.
   1. Brady Corporation
   2. Carlton Industries, LP
   3. emedco
   4. Marking Services, Inc.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS
A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION
3.1 PREPARATION
A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION
A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
B. Install identifying devices before installing acoustical ceilings and similar concealment.
C. Verify identity of each item before installing identification products.
D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
E. Apply identification devices to surfaces that require finish after completing finish work.
F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.
I. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
   1. "EMERGENCY POWER."
   2. "POWER."
   3. "UPS."
J. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
   1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
K. Laminated Acrylic or Melamine Plastic Signs:
   1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use labels 2 inches (50 mm) high.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Arc Flash Warning Labeling: Self-adhesive labels.
   2. Comply with Section 260574 “Overcurrent Protective Device Arc-Flash Study” requirements for arc-flash warning labels.

D. Equipment Identification Labels:
   1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      e. Disconnects for any equipment provided by Owner or other trade.
      f. All electrical equipment or devices which are not located within sight of their source of power shall have nameplates listing their source of power (panelboard or switchboard name and number) along with voltage, circuit number, and load served.

   END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION
   A. The requirements of this section apply to all sections of Division 26 and Division 28.
   B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Division 1 Section "General Commissioning Requirements." The commissioning process, which the Contractor is responsible to execute, is defined in Division 1 Section "General Commissioning Requirements." A commissioning agent (CxA) will manage the commissioning process.

1.2 RELATED WORK
   A. Division 1 Section "General Requirements."
   B. Division 1 Section "General Commissioning Requirements."
   C. Division 1 Section "Shop Drawings, Product Data, and Samples."

1.3 SUMMARY
   A. This section includes requirements for commissioning Electrical systems, subsystems, and equipment. This section supplements the general requirements specified in Division 1 Section "General Commissioning Requirements."
   B. The commissioning activities have been developed to support requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
   C. Refer to Division 1 Section "General Commissioning Requirements" for more specifics regarding processes and procedures as well as roles and responsibilities for all commissioning team members.

1.4 DEFINITIONS
   A. Refer to Division 1 Section "General Commissioning Requirements" for definitions.

1.5 COMMISSIONED SYSTEMS
   A. Commissioning of a system or systems specified in this division is part of the construction process. Documentation and testing of these systems, as well as training of the operations and maintenance personnel, is required in cooperation with the Commissioning Agent.
   B. The following Electrical systems will be commissioned:
      1. Lighting Control System.
      2. Access Control.

1.6 SUBMITTALS
   A. The commissioning process requires review of selected submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the engineer prior to forwarding to the Contractor. Refer to Division 1 Section "Shop Drawings, Product Data, and Samples" for further details.
B. The commissioning process requires submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Division 1 Section "General Commissioning Requirements."

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete pre-functional checklists to verify that systems, subsystems, and equipment installation is complete and systems are ready for systems functional performance testing. The Commissioning Agent will prepare pre-functional checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the engineer and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists also is inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Division 1 Section "General Commissioning Requirements" for submittal requirements for Pre-functional checklists, equipment startup reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 26 and Division 28 shall be scheduled and documented in accordance with Division 1 Section "General Requirements." The Commissioning Agent will witness selected contractor tests. Contractor tests shall be completed prior to scheduling systems functional performance testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. The commissioning process includes systems functional performance testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed systems functional performance test procedures for review and approval by the resident engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Division 1 Section "General Commissioning Requirements" for additional details.

3.4 TRAINING

A. Training of operations and maintenance personnel is required in cooperation with the engineer and Commissioning Agent. Provide competent, factory-authorized personnel to provide instruction to operations and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the resident engineer after submission and approval of formal training plans. Refer to Division 1 Section "General Commissioning Requirements" and Division 26 and Division 28 sections for additional Contractor training requirements.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Time switches.
      2. Photoelectric switches.
      3. Distributed digital lighting control system.

1.3 DEFINITIONS
   A. LED: Light-emitting diode.
   B. PIR: Passive infrared.
   C. SPST: Single pole single throw.
   D. BAS: Building automation system.
   E. Low Voltage: As defined in NFPA 70, the term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.
   F. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
   G. Zone: A luminaire or group of luminaires controlled simultaneously as a single entity. Also known as a "channel."

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show installation details for all components.
      1. Interconnection diagrams showing field-installed wiring.
   C. Field quality-control test reports.
   D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION
   A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them.

1.7 WARRANTY
   A. Special Warranty: Manufacturer agrees to repair or replace components of standalone multipreset modular dimming controls that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Damage from transient voltage surges.
2. **Warranty Period:** Cost to repair or replace any parts for two years from date of Substantial Completion.

3. **Extended Warranty Period:** Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

**PART 2 - PRODUCTS**

### 2.1 OUTDOOR PHOTOELECTRIC SWITCHES

**A. Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
2. Lithonia Lighting; Acuity Lighting Group, Inc.
3. Novitas, Inc.
5. Square D; Schneider Electric.
6. TORK.

**B. Description:** Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. **Light-Level Monitoring Range:** 1.5 to 10 fc (16 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. **Time Delay:** 15-second minimum, to prevent false operation.
4. **Mounting:** Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

### 2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

**A. Manufacturers**

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Wattstopper Digital Lighting Management (DLM) or comparable product by one of the following:
   a. Acuity Brands.
   b. Creston Electronics
   c. Douglas Lighting Controls

**B. System General:** The lighting control system shall control all the lights in the facility except those in mechanical, electrical, and telecomm rooms, and the elevator machine room and tunnel. Provide Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.

1. **Space Control Requirements:** Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated and Automatic-ON occupancy sensors as indicated. Provide Manual-ON occupancy/vacancy sensors as indicated. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
2. **Day Lit Areas:** Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
   a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of day lit zones.
b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.

c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.

d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

3. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

C. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.

1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.

2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.

3. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.

4. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.

5. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control. Provide wall mounted sensors that are amiable at 45 degrees off of vertical for the 2-story space.

6. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.

7. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.

D. Local Network LMRJ-Series: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.

1. Features of the DLM local network include:
   a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
   b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
   c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
   d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.

3. If manufacturer’s pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.3 DIGITAL LOAD CONTROLLERS

A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n’ Go applications. Control units include the following features:

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller’s device ID’s from highest to lowest.
4. Device Status LEDs to indicate:
   a. Data transmission.
   b. Device has power.
   c. Status for each load.
   d. Configuration status.
5. Quick installation features including:
   a. Standard junction box mounting.
   b. Quick low voltage connections using standard RJ-45 patch cable.
6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
   a. Turn on to 100 percent.
   b. Turn off.
   c. Turn on to last level.
7. Each load be configurable to operate in the following sequences based on occupancy:
   a. Auto-on/Auto-off (Follow on and off).
   b. Manual-on/Auto-off (Follow off only).
8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
9. BACnet object information shall be available for the following objects:
   a. Load status.
   b. Schedule state, normal or after-hours.
   c. Demand Response enable and disable.
   d. Room occupancy status.
   e. Total room lighting and plug loads watts.
   f. Electrical current.
   g. Total watts per controller.
   h. Total room watts/sq ft.
   i. Force on/off all loads
10. UL 2043 plenum rated.
12. Zero cross circuitry for each load.
13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

14. Dimming Room Controllers shall share the following features:
   a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
   b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
   c. The following dimming attributes may be changed or selected using a wireless configuration tool:
      1) Establish preset level for each load from 0-100 percent.
      2) Set high and low trim for each load.
      3) Initiate lamp burn in for each load of either 0, 12 or 100 hours.
   d. Override button for each load provides the following functions:
      1) Press and release for on/off control.
      2) Press and hold for dimming control.
   e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
   f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
   g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
   h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

B. On/Off Room Controllers shall include:
   1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load.
   2. One or two relay configuration.
   3. Simple 150 mA switching power supply (Only 4 100 series devices on a Cat 5e local network).
   4. Three RJ-45 DLM local network ports with integral strain relief and dust cover.

C. On/Off/0-10V Dimming KO Mount Room Controllers shall include:
   1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 10A total load.
   2. Optional real time current and voltage monitoring (with - M Monitoring option).
   3. One or two relays configurations.
   4. Smart 150 mA switching power supply.
   5. Two RJ-45 DLM local network ports. Provide molded strain relief ring
   6. One dimming output per relay:
      a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
   7. Units capable of providing both Class 1 or Class 2 wiring for the 0-10V output.
   8. WattStopper product numbers: LMRC-111, LMRC-111-M, LMRC-112, or LMRC-112-M.

2.4 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

A. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton configuration for the following variables:
      a. Sensitivity, 0-100 percent in 10 percent increments.
      b. Time delay, 1-30 minutes in 1 minute increments.
c. Test mode, Five second time delay.

d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.

e. Walk-through mode.

2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

3. Programmable control functionality including:
   a. Each sensor may be programmed to control specific loads within a local network.
   b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
   c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
   d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
   e. Ultrasonic and Passive Infrared.
   f. Ultrasonic or Passive Infrared.
   g. Ultrasonic only.
   h. Passive Infrared only.
   i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

4. One or two RJ-45 port(s) for connection to DLM local network.

5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

6. Device Status LEDs, which may be disabled for selected applications, including:
   a. PIR detection.
   b. Ultrasonic detection.
   c. Configuration mode.
   d. Load binding.

7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.


9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Detection state.
   2. Occupancy sensor time delay.
   3. Occupancy sensor sensitivity, PIR and Ultrasonic.

C. Units shall not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.5 DIGITAL WALL SWITCH OCCUPANCY SENSORS

A. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton configuration for the following variables:
      a. Sensitivity: 0-100 percent in 10 percent increments.
      b. Time delay: 1-30 minutes in 1 minute increments.
      c. Test mode: Five second time delay.
      d. Detection technology: PIR, Dual Technology activation and/or re-activation.
2. Programmable control functionality including:
   a. Each sensor may be programmed to control specific loads within a local network.
   b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
   c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
   d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
      1) Ultrasonic and Passive Infrared.
      2) Ultrasonic or Passive Infrared.
      3) Ultrasonic only.
      4) Passive Infrared only.
   e. Walk-through mode.
   f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

4. Two RJ-45 ports for connection to DLM local network.

5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.

6. Device Status LEDs including
   a. PIR detection.
   b. Ultrasonic detection.
   c. Configuration mode.
   d. Load binding.

7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.

8. Assignment of local buttons to specific loads within the room without wiring or special tools.


10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Detection state.
   2. Occupancy sensor time delay.
   3. Occupancy sensor sensitivity, PIR and Ultrasonic.
   4. Button state.
   5. Switch lock control.
   6. Switch lock status.

C. Units shall not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
   1. Left button:
      a. Press and release - Turn load on.
      b. Press and hold - Raise dimming load.
   2. Right button:
      a. Press and release - Turn load off.
      b. Press and hold - Lower dimming load.
F. Low voltage momentary pushbuttons shall include the following features:
   1. Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED
      b. Dim locator level indicates power to switch
      c. Bright status level indicates that load or scene is active
   2. The following button attributes may be changed or selected using a wireless configuration tool:
      a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
      b. Individual button function may be configured to Toggle, On only or Off only.
      c. Individual scenes may be locked to prevent unauthorized change.
      d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
      e. Ramp rate may be adjusted for each dimmer switch.
      f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
      g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.6 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
   1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
   2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
   3. Configuration LED on each switch that blinks to indicate data transmission.
   4. Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED.
      b. Dim locator level indicates power to switch.
      c. Bright status level indicates that load or scene is active.
      d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
   5. Programmable control functionality including:
      a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority.
      b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
   6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Button state.
   2. Switch lock control.
   3. Switch lock status.

C. Two RJ-45 ports for connection to DLM local network.

D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
   1. Individual button function may be configured to Toggle, On only or Off only.
   2. Individual scenes may be locked to prevent unauthorized change.
3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
4. Ramp rate may be adjusted for each dimmer switch.
5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

2.7 MASTER CONTROL STATION
   A. LCD touchscreen graphical user interface typical of Equinox 73.
      1. Nominal 7” diagonal glass liquid crystal touchscreen that protrudes no more than 1/2” from wall.
      2. Programmable, multi-system dashboard with intuitive navigation and modification of settings, scenes and tasks.
      3. Access and control of remote scene control, scene assignments and scene operation throughout the facility.

2.8 DIGITAL DAYLIGHTING SENSORS
   A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
      1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
      2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
      3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone
   B. Digital daylighting sensors shall include the following features:
      1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
      2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
      3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
      4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
      5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
      6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
      7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
      8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
10. Configuration LED status light on device that blinks to indicate data transmission.
11. Status LED indicates test mode, override mode and load binding.
12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. Provide wall mounted sensors that are amiable at 45 degrees off of vertical for the 2-story space.
14. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
   a. Light level.
   b. Day and night setpoints.
   c. Off time delay.
   d. On and off setpoints.
   e. Up to three zone setpoints.
   f. Operating mode - on/off, bi-level, tri-level or dimming
15. One RJ-45 port for connection to DLM local network.
16. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.
17. Any load or group of loads in the room can be assigned to a daylighting zone.
18. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
19. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

2.9 NETWORK BRIDGE

A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
2. Provide Plug n’ Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
3. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
   a. Read/write the normal or after hours schedule state for the room.
   b. Read the detection state of each occupancy sensor.
   c. Read the aggregate occupancy state of the room.
   d. Read/write the On/Off state of loads.
   e. Read/write the dimmed light level of loads.
f. Read the button states of switches.
g. Read total current in amps, and total power in watts through the load controller.
h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings.
i. Activate a preset scene for the room.
j. Read/write daylight sensor fade time and day and night setpoints.
k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells.
l. Set daylight sensor operating mode.
m. Read/write wall switch lock status.
n. Read watts per square foot for the entire controlled room.
o. Write maximum light level per load for demand response mode.
p. Read/write activation of demand response mode for the room.
q. Activate/restore demand response mode for the room.


2.10 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

A. Hardware: Provide LMCP lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.

2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.

3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
   a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
   b. Individual terminal block, override pushbutton, and LED status light for each relay.
   c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
   d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
   e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
   f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
   g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
   h. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
   a. Electrical:
      1) 30 amp ballast at 277V.
      2) 20 amp ballast at 347V.
      3) 20amp tungsten at 120V.
      4) 30 amp resistive at 347V.
      5) 1.5 HP motor at 120V.
      6) 14,000 amp short circuit current rating (SCCR) at 347V.
      7) Relays shall be specifically UL 20 listed for control of plug-loads.
   b. Mechanical:
      1) Replaceable, 1/2 inch KO mounting with removable Class 2 wire harness.
      2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
      3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
      4) Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
   a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 networked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
   b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
   c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
   d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
      1) Scheduled ON / OFF
      2) Manual ON / Scheduled OFF
      3) Astro ON / OFF (or Photo ON / OFF)
      4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
   e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
   f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
   g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.

10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperability with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.
   a. Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
   b. Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
   c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
   d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.
   e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
   f. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
      1) Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
      2) Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
      3) Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
      4) Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
   g. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
   h. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)
   i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
   j. Lockout of all digital switch buttons connected to a given panel shall be commandable via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
   a. Use the same intelligence board as the LMCP relay panel.
   b. Shall not include relay driver boards or relays.
c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is
   for surface mounting applications only.

d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each
   installed Power Booster can provide an additional 150 mA for either of the two
   available DLM local networks provided by the LMZC.

e. All programming and networking (whether DLM Local Network and/or Segment
   Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for
   LMC relay panels, except for functions designed for panel-mounted HDR relays.

12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone
    Controller, Plug n' Go automatic configuration will establish a unique sequence of operation
    so that all LMFC-controlled fixtures will turn on to 50 percent output when any digital
    occupancy sensor detects motion.

13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone
    Controller: LMZC-301.

B. User Interface: Each lighting control panel system shall be supplied with at least one handheld
   configuration tool (LMCT-100). As a remote programming interface the configuration tool shall
   allow setup, configuration, and diagnostics of the panel without the need for software or
   connection of a computer. User interface shall have the following panel-specific functions as a
   minimum:

   1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and
      max master range.

   2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all
      seven key relay parameters for member relays. The seven parameters are as follows: After-
      hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to
      Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours,
      Sensor Action During After Hours, Blink-Warn Time for After Hours.

   3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals
      with each day selectable as active or inactive, and shall be configurable as to whether the
      event is active on holidays. Holidays are also defined through the User Interface.

   4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as
      either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V
      analog photocell. Dark/Light events shall occur on seven day intervals with each day
      selectable as active or inactive, and shall be configurable as to whether the event is active
      on holidays.

   5. Button binding of digital switches to groups shall be accessible via the handheld IR remote
      and accomplished from the digital switch station.

   6. Programming of panel location information shall be accomplished by the handheld IR
      remote and include at a minimum LAT, LON, DST zone, and an approximate city/state
      location.

   7. WattStopper Product Number: LMCT-100

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

   A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas
      indicated. Do not exceed coverage limits specified in manufacturer’s written instructions.

3.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM INSTALLATION

   A. Install system in accordance with the approved system shop drawings and manufacturer's
      instructions.

   B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated
      RJ-45 connectors.

      1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be
         tested following installation and testing results submitted to the Manufacturer's
         Representative for approval prior to proceeding with the Work.
2. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty.

3. Low voltage wiring topology must comply with manufacturer's specifications.

4. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

C. All line voltage connections shall be tagged to indicate circuit and switched legs.

D. Test all devices to ensure proper communication.

E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)

G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.

H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.

I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer’s written instructions.

C. Size conductors according to lighting control device manufacturer’s written instructions.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section “Identification for Electrical Systems.”
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing:
1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Tests and Inspections: Manufacturer’s service representative shall perform the following inspections and prepare reports.
1. Verify Class I and II wiring connections are terminated properly by validating system performance.
2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
4. Verify that the control of each space complies with the Sequence of Operation.
5. Correct any system issues and retest.

C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer’s system software including each room or space that has lighting control installed. Indicate the following:
1. Date of test or inspection.
2. Loads per space, or Fixture Address identification.
3. Quantity and Type of each device installed
4. Reports providing each device’s settings.

D. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements. Test for compliance with requirements.

3.6 PROGRAMMING
A. Coordinate light levels, scene arrangements and control with the library staff to meet their operational needs.
B. Program system and devices to provide the controls needed.

3.7 ADJUSTING
A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section “Demonstration and Training.”

3.9 PRODUCT SUPPORT AND SERVICE
A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

3.10 COMMISSIONING
A. See Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS
A. ATS: Acceptance testing specification.
B. GFCI: Ground-fault circuit interrupter.
C. GFEP: Ground-fault equipment protection.
D. HID: High-intensity discharge.
E. MCCB: Molded-case circuit breaker.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of panelboard.
   1. Include materials, switching and overcurrent protective devices, accessories, and components indicated.
   2. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, and finishes.
B. Shop Drawings: For each panelboard and related equipment.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.
   7. Include dimensioned plans, elevations, sections, and details.
   8. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
   9. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
   10. Detail bus configuration, current, and voltage ratings.
   11. Short-circuit current rating of panelboards and overcurrent protective devices.
   12. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   13. Include wiring diagrams for power, signal, and control wiring.
   14. Key interlock scheme drawing and sequence of operations.
   15. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device.
   16. Include report of emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.
1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified testing agency.
   B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Keys: Two spares for each type of panelboard cabinet lock.
      2. Circuit Breakers Including GFCl and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard using this breaker type.

1.7 QUALITY ASSURANCE
   A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
   B. Handle and prepare panelboards for installation according to NECA 407.

1.9 FIELD CONDITIONS
   A. Environmental Limitations:
      1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
      2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
         a. Ambient Temperature: Not exceeding [minus 22 deg F (minus 30 deg C)] [23 deg F (minus 5 deg C)] to plus 104 deg F (plus 40 deg C).
   B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
      1. Notify Owner no fewer than ten days in advance of proposed interruption of electric service.
      2. Do not proceed with interruption of electric service without Owner's written permission.
      3. Comply with NFPA 70E.

1.10 WARRANTY
   A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
      1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
PART 2 PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush- and surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   2. Height: 84 inches (2.13 m) maximum.
   3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
   4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
   5. Finishes:
      a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

F. Incoming Mains:
   1. Location: Top or Bottom.
   2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:
      a. Plating shall run entire length of bus.
      b. Bus shall be fully rated the entire length.
   2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   4. Isolated Ground Bus (where noted on drawings): Adequate for branch-circuit isolated ground conductors; insulated from box. Where isolated ground transformers or feeders shown on the one-line diagram.
   5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
   6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Rated 200 percent of full load current for K-factor rated transformers, and any transformer shown on the riser diagrams or one-line diagrams with 200% rated feeders.
   7. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Terminations shall allow use of 75 deg C rated conductors without derating.
   3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

I. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
   1. Percentage of Future Space Capacity: Ten percent.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
   1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: As indicated on drawings and schedules.


F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated on drawings and schedules.
D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

C. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers:
      a. Inverse time-current element for low-level overloads.
      b. Instantaneous magnetic trip element for short circuits.
      c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   4. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
   5. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
   7. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Breaker handle indicates tripped status.
      c. UL listed for reverse connection without restrictive line or load ratings.
      d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      e. Application Listing: Appropriate for application; Type SVD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      g. Shunt Trip (where identified on drawings or schedules): 24-V trip coil energized from separate circuit, set to trip at 70 percent of rated voltage.
      h. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
      i. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
      j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
      k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
2.5 IDENTIFICATION
A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES
A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
B. Handle Padlock Attachment: Handle attachment for 1, 2, or 3 pole breakers to lock breaker in ON or OFF position.

PART 3 EXECUTION
3.1 EXAMINATION
A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
B. Receive, inspect, handle, and store panelboards according to NECA 407.
C. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Comply with NECA 1.
C. Install panelboards and accessories according to NECA 407.
D. Equipment Mounting:
   1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
F. Mount top of trim at a maximum of 90 inches (2286 mm) above finished floor unless otherwise indicated. Operating handle of top-most circuit breaker, in on position, shall not be higher than 79 inches (2000 mm) above finished floor or grade.
G. Mount panelboard cabinet plumb and rigid without distortion of box.
H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
   2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch (27-EMT) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-EMT) empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Submit report to show emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.

3.5 ADJUSTING
   A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
   B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."
   C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
      1. Measure as directed during period of normal system loading.
      2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
      3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
      4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION
   A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 CLEANING
   A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION
SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Straight-blade convenience, isolated-ground, and tamper-resistant receptacles.
   2. USB charger devices.
   3. GFCI receptacles.
   4. Twist-locking receptacles.
   5. Pendant cord-connector devices.
   6. Toggle switches.
   7. Wall plates.
   8. Floor service outlets.
   11. Service poles.

1.2 DEFINITIONS
A. Abbreviations of Manufacturers' Names:
   1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
B. BAS: Building automation system.
C. EMI: Electromagnetic interference.
D. GFCI: Ground-fault circuit interrupter.
E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Provide separate submittal directly to the Architect for approval of color and finishes of devices and plates. This submittal shall include all samples. Any devices submittal will be reviewed for technical performance only. Color and finishes must be approved by the project Architect.
1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing-label
warnings and instruction manuals that include labeling conditions.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective
covering for storage and identified with labels describing contents.
1. Service/Power Poles: One for every 10, but no fewer than one.
2. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but
no fewer than two.

PART 2 PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS
A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by
a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.
C. Devices that are manufactured for use with modular plug-in connectors may be substituted
under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.
D. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.
E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source
from single manufacturer.

2.2 MANUFACTURERS
A. Manufacturers’ Names: Shortened versions (shown in parentheses) of the following manufacturers’
names are used in other Part 2 articles:
   1. Eaton. (Arrow Hart is acceptable only where noted.)
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

2.3 STRAIGHT-BLADE RECEPTACLES
A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6
Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be
   incorporated into the Work include, but are not limited to, the following:
      a. Eaton; 5361 (single), 5362 (duplex). (Arrow Hart AH5362)
      b. Hubbell; HBL5361 (single), HBL5352 (duplex).
      c. Leviton; 5361 (single), 5362 (duplex).
      d. Pass & Seymour; 5361 (single), 5362 (duplex).
B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; IG5362. (Arrow Hart IG5362)
      b. Hubbell; IG5362.
      c. Leviton; 5362IG.
      d. Pass & Seymour; IG5362.
   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 USB CHARGER DEVICES
A. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton: TR7745 (15A), TR7746 (20A)
      b. Hubbell: USB15X2
      c. Leviton: T5630
      d. Pass & Seymour: TM8USB*CC6
   3. USB Receptacles: Dual, Type A.
   4. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.5 GFCI RECEPTACLES
A. General Description:
   1. 2015 UL 943/CSA C22.2 No 144.1/ANCE NMX-J-250 Compliant.
   2. Self-testing, auto-monitoring with test-fail indication, with disconnection of power in case of test failure.
   3. Straight blade, feed-through type.
   4. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   5. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Hubbell; GFRST20.
      c. Leviton; GFNT2.
      d. Pass & Seymour; 2097.
C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton TRSGF20
      b. Hubbell; GFTRST20.
      c. Leviton GFTR2
      d. Pass & Seymour; 1597TR.
2.6 PLUG-IN TYPE DEVICES
A. Equivalent devices to those listed above (receptacles) and below (switches) from the following manufactures in the series listed may be used instead of traditional wired devices.
   1. Eaton: ArrowLink Modular Wiring Devices.
   3. Leviton: Lev-Lok Modular Wiring Devices
   4. Pass & Seymour: PlugTail Modular Wiring Devices
B. Description:
   1. Device shall be plug connected, with a pigtail connector. The pigtail shall be connected to the building wiring. Provision shall be made for the pigtail connector to keep out construction debris including drywall compound, paint, and dust.
   2. Device shall comply with all standards for traditional wired device and be equivalent grade and function as traditional wired device it replaces.

2.7 PLUG LOAD CONTROLLABLE RECEPTACLES
A. Equivalent devices to those listed above (receptacles) from the following manufactures in the series listed shall be used instead of traditional devices on circuits indicated with plug-load control.
   1. Eaton: N/A
   2. Hubbell: N/A
   3. Leviton: 5362-1P Half & 5362-2P Dual Controlled Receptacles
   4. Pass & Seymour: 5362CH Half & 5362CD Dual Controlled Receptacles
B. Description:
   1. Permanently marked controlled receptacle marking printed on the face of the device.

2.8 TWIST-LOCKING RECEPTACLES
A. Twist-Lock, Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; CWL520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; IGL520R.
      b. Hubbell; IG2310.
      c. Leviton; 2310-IG.
      d. Pass & Seymour; IG4700.
   2. Description:
      a. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
      b. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
2.9 PENDANT CORD-CONNECTOR DEVICES
A. Description:
   1. Matching, locking-type plug and receptacle body connector.
   2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
   4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.10 CORD AND PLUG SETS
A. Description:
   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

2.11 TOGGLE SWITCHES
A. Comply with NEMA WD 1, UL 20, and FSW-S-896.
B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Single Pole:
         1) Eaton; AH1221.
         2) Hubbell; HBL1221.
         3) Leviton; 1221-2.
         4) Pass & Seymour; CSB20AC1.
      b. Two Pole:
         1) Eaton; AH1222.
         2) Hubbell; HBL1222.
         3) Leviton; 1222-2.
         4) Pass & Seymour; CSB20AC2.
      c. Three Way:
         1) Eaton; AH1223.
         2) Hubbell; HBL1223.
         3) Leviton; 1223-2.
         4) Pass & Seymour; CSB20AC3.
      d. Four Way:
         1) Eaton; AH1224.
         2) Hubbell; HBL1224.
         3) Leviton; 1224-2.
         4) Pass & Seymour; CSB20AC4.
C. Pilot-Light Switches, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; AH1221PL for 120 and 277 V.
      b. Hubbell; HBL1201PL for 120 and 277 V.
      c. Leviton; 1221-LH1.
      d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
   2. Description: Single pole, with LED-lighted handle, illuminated when switch is off.
2.12 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Smooth, high-impact thermoplastic; Match existing or color as selected by project designer.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.13 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
B. Compartments: Barrier separates power from voice and data communication cabling.
C. Service Plate: Round, solid brass with satin finish.
D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.14 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Pass & Seymour/Legrand.
   3. Square D/Schneider Electric.
   4. Thomas & Betts Corporation.
   5. Wiremold/Legrand.

B. Description:
   1. Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
   2. Comply with UL 514 scrub water exclusion requirements.
   3. Service-Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks complying with requirements in Section 271500 "Communications Horizontal Cabling."
   4. Size: Selected to fit nominal 3-inch (75-mm) cored holes in floor and matched to floor thickness.
   5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   6. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
   7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 271500 "Communications Horizontal Cabling."

2.15 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Wiremold/Legrand.
B. Description:
   1. Two-piece surface metal raceway, with factory-wired multi-outlet harness.
   2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multi-outlet Harness:
   1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
   2. Receptacle Spacing: 12 inches (300 mm).
   3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

2.16 SERVICE POLES

A. Description:
   1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   2. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
   3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
   4. Finishes: Manufacturer's standard painted finish and trim combination.
   5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5 voice and data communication cables.
   6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.

2.17 FINISHES

A. Device Color:
   1. Wiring Devices Connected to Normal Power System: Match existing or as selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
   3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.
C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtailed.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtauling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtailed that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtailed for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

I. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for rough-in of conduit and equipment, the contractor shall check with other contractors concerned, to determine exact field location of the above items. In addition, he shall check for exact direction of door swings so that local switches are properly located on the strike side.

J. Where more than one wiring device occurs in any one location, arrange devices in gangs with common cover plate, excluding wall box dimmers. Where ganged switches serving 277V lighting are served by different circuits, so as to result in the voltage between switches exceeding 300V, provide barriers in box per NEC Section 404-8(b).

K. In locations where several pieces of wall-mounted equipment such as wall switches and thermostats are in the same general area, all shall be installed and grouped in a neat, orderly fashion, all of the same horizontal or vertical center line, whichever the case may be. Variation
from this direction shall be approved by the owner or the owner’s representative. All receptacles and switches shall be mounted at a height as directed in drawings.

L. Install devices, accessories, and assemblies level, plumb, square with building lines, and secure.

M. Install GFCI type receptacles where located in bathrooms, kitchens, garages, outdoors, or within six feet of a water source.

N. Install GFCI type receptacles at all locations indicated as EWC (electric water cooler).

O. Install GFCI type receptacles at all locations for vending machines.

P. Install GFCI type receptacle with an in-use weatherproof cover for all receptacles indicated as weatherproof.

Q. Devices mounted in boxes which are not flush with the surface of the wall shall be installed so that the mounting yoke or strap of the device is held rigidly at the surface of the wall, but not supported by the wall. Provide washers or spacers to fill in the area between the box and the finished wall line.

R. Receptacles shall be installed so that the removal of the receptacle does not interrupt the continuity of the circuit.

S. Receptacles and switches shall have their device screws covered by two wraps of PVC electrical tape. Receptacles with integral hinged plastic covers meet this requirement.

T. For installations of multi-outlet assemblies or service poles using multiple circuits, provide a multi-pole circuit breaker in panelboard for branch circuits.

3.2 GFCI RECEPTACLES
A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION
A. Comply with Section 260553 "Identification for Electrical Systems."

B. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

C. Identify each receptacle with panelboard identification and circuit number. Use durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL
A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION
SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.2 DEFINITIONS
A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.
B. Shop Drawings: For enclosed switches and circuit breakers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.
   3. Provide coversheet indicating project title, project location, and vendor contact information.
   4. Organize submittal into logical sections and provide table of contents.
   5. Provide itemized bill of materials indicating model number and quantity for each product.
   6. On datasheets with multiple products, indicate which product is provided under this project.
   7. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   8. Manufacturers' catalog sheets with complete technical data for each item being furnished.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified testing agency.
B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
      2. Fuse Pullers: Two for each size and type.

1.7 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Accredited by NETA.
      1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 FIELD CONDITIONS
   A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

1.9 WARRANTY
   A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
      1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS
   A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
   B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
   C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
   D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES
   A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.
   B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1. ABB Inc.
      2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
5. Square D; a brand of Schneider Electric.

C. Type HD, Heavy Duty:
1. Single throw.
2. Three pole.
3. 240 or 600-V ac.
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

C. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
D. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

E. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 140 deg F (60 deg C) rated wire on 125-A circuit breakers and below.

G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.


I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I²t response.

K. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

C. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
PART 3 EXECUTION

3.1 EXAMINATION
A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION
A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
   4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS
A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

3.4 INSTALLATION
A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in fusible devices.
E. Comply with NEC 1.

3.5 IDENTIFICATION
A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:
   1) Use a low-resistance ohmmeter.
      (a) Compare bolted connection resistance values to values of similar connections.
      Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
      (a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:
   1) Use a low-resistance ohmmeter.
      (a) Compare bolted connection resistance values to values of similar connections.
      Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
      (a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
   c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
   e. Determine the following by primary current injection:
      1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
   f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
   g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
   h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
   i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.
   1. Test procedures used.
   2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
   3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION
SECTION 26 51 19
LED INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Interior solid-state luminaires that use LED technology.
   2. Lighting fixture supports.
B. Related Requirements:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.2 DEFINITIONS
A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Arrange in order of luminaire designation.
   8. Include data on features, accessories, and finishes.
   9. Include physical description and dimensions of luminaires.
10. Include emergency lighting units, including batteries and chargers.
11. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
12. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.
   a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

c. Provide certification of one of the following:
   1) LM-79-08 report at T=0 and at T=6000 hours with a summary table showing the percent lumen output change and percent input power change.
   2) LM-80-08 test data for the LEDs at the three temperatures per LM-80-08. Provide extrapolation data using an exponential decay function to show the output at 50,000 hours. Provide the Ts value from the LM-79-08 and where the point falls in relation to the LM-80-08 extrapolated data. Interpolate between the LM-80-08 data for the Ts temperature.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of luminaire.

D. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. LEDs: Provide One for every 100 factory assembled replacement LED package with electrical leads. Furnish at least one of each type. May be unitized with power supply unit/driver.
   2. Power Supply Units/driver: One for every 100 of each type and rating installed. Furnish at least one of each type. May be unitized with LEDs.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.
D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY
A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
B. Warranty Period for Light Sources: Five year replacement material warranty on all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor for the LEDs lumen maintenance not achieving L70 after 75,000 hours.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 LUMINAIRE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL, ETL, CSA, or other qualified testing agency, and marked for intended location and application.
B. Standards:
1. ENERGY STAR certified.
2. California Title 24 compliant.
3. DLC Certified.
4. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
5. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
6. UL Listing: Listed for damp location.
7. Recessed luminaires shall comply with NEMA LE 4.
8. User Replaceable Lamps:
   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61 or IEC 60061-1.
C. CRI of minimum 70. CCT of 3500K.
D. Rated lamp life of 75,000 hours.
E. Lamps dimmable from 100 percent to 1 percent of maximum light output.
F. Internal driver.
G. Nominal Operating Voltage: As scheduled.

2.3 LEDS
A. LED sources must meet the following requirements:
   1. Operating temperature rating must be between -40°C and +50°C
      b. Du’v’ tolerance of 0.001 ± 0.006
   3. Color Rendering Index (CRI): greater than or equal to 80.
4. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
   a. High Temperature Operating Life (HTOL)
   b. Room Temperature Operating Life (RTOL)
   c. Low Temperature Operating Life (LTOL)
   d. Powered Temperature Cycle (PTMCL)
   e. Non-Operating Thermal Shock (TMSK)
   f. Mechanical Shock
   g. Variable Vibration Frequency
   h. Solder Heat Resistance (SHR)

2.4 LED DRIVERS / POWER SUPPLYS

A. LED drivers must meet the following requirements:
   1. Drivers must have a minimum efficiency of 85%.
   2. Starting Temperature: -40° C.
   3. Electrical Characteristics.
      a. Volts: as indicated on Luminaire Schedule.
      b. Phase: Single.
      c. Hertz: 60.
   4. Power supplies can be UL Class I or II output.
   5. Drivers must have a Power Factor (PF) of greater than or equal to 0.90.
   6. Drivers must have a Total Harmonic Distortion (THD) of less than or equal to 20%.
   8. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
   9. Inrush current <2A
   10. Sound rating: Inaudible in a 24 dB ambient.
   11. Class P thermally protected.

2.5 LED LUMINAIRES

A. Provide luminaires with integral LED thermal management system (heat sinking).

B. Luminaires shall be equipped with an LED driver that accepts 120V through 277V, 50hz to 60hz (UNIV). Component-to-component wiring within the luminaire will carry no more than 80% of rated current and be listed by UL for use at 600 VAC at 302°F/150°C or higher. Plug disconnects shall be listed by UL for use at 600 VAC, 15A or higher.

C. LED modules shall have a minimum L70 service life of 75,000 hours at 25°C ambient temperature and based on IESNA LM-80 methodology.

D. Provide luminaires with individual LED arrays/ modules and drivers that are accessible and replaceable from exposed side of the luminaire. Luminaires requiring removal or replacement of entire luminaire to access LEDs and drivers will NOT be accepted.

E. Luminaire efficiency shall be minimum of 100 lumens per watt.

F. Warranty: 5 year warranty covering the LED arrays, and LED drivers.

G. Continuous Flicker Free dimming range 100% to 1% measured relative light output.

2.6 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors,
frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

C. Diffusers and Globes:
   1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.7 METAL FINISHES
   A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be assembled or installed to minimize contrast.

2.8 LUMINAIRE SUPPORT
   A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
   B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
   C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
   D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
   E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING
   A. If approved by the Architect, use selected permanent luminaires for temporary lighting not to exceed 2,500 hours of use for LED luminaries. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION
   A. Comply with NECA/IESNA-500, "Recommended Practice for Installing Indoor Commercial Lighting Systems."
   B. Comply with NECA 1.
C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

F. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

G. Wall-Mounted Luminaire Support:
   1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
   2. Do not attach luminaires directly to gypsum board.

H. Ceiling-Mounted Luminaire Support:
   1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.

I. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
   4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

K. Light Track: Support track on maximum of 4 foot centers.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.
D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
E. Advance Notice: Give dates and times for field tests.
F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
G. Corroded Fixtures: Replace during warranty period.

3.6 STARTUP SERVICE
A. Comply with requirements for startup specified in Section 260923 "Lighting Control Devices."
B. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

3.7 ADJUSTING
A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
B. During adjustment visits, inspect all luminaires. Replace luminaires that are defective.
C. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
D. Adjust the aim of luminaires in the presence of the Architect.
E. Adjust aimable luminaires according to the directions shown on lighting drawings or per Owner’s direction.

3.8 INTERIOR LUMINAIRE SCHEDULE
A. See drawings for Luminaire Schedule.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Emergency lighting units.
   2. Exit signs.
   3. Luminaire supports.

1.2 DEFINITIONS
A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
D. Fixture: See "Luminaire" Paragraph.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Include data on features, accessories, and finishes.
   8. Include physical description of the unit and dimensions.
   9. Battery and charger for light units.
   10. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
   11. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
      a. Manufacturers’ Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
B. Product Schedule:
   1. For emergency lighting units. Use same designations indicated on Drawings.
   2. For exit signs. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing laboratory providing photometric data for luminaires.
B. Product Certificates: For each type of luminaire.
C. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.

1.7 QUALITY ASSURANCE
A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY
A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
   2. Warranty Period for Emergency Fluorescent Ballast Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining six years.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
C. Comply with NFPA 70 and NFPA 101.
D. Comply with NEMA LE 4 for recessed luminaires.
E. Comply with UL 1598 for fluorescent luminaires.
F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.
G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.
   1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
   2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
      b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
      c. Humidity: More than 95 percent (condensing).
      d. Altitude: Exceeding 3300 feet (1000 m).
   4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
      a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   5. Battery: Sealed, maintenance-free, lead-acid type.
   6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
   7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

I. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
   1. Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire driver.
   2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Battery: Sealed, maintenance-free, lead-acid type.
   5. Charger: Fully automatic, solid-state, constant-current type.
   6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
   7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

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2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.
   1. Emergency Luminaires: As indicated on Interior Lighting Fixture Schedule, with the following additional features:
      a. Operating at nominal voltage of 120 V/277 V ac.
      b. Internal emergency power unit.
      c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.

B. Emergency Lighting Unit:
   1. Emergency Lighting Unit: As indicated on Interior Lighting Fixture Schedule.
   2. Operating at nominal voltage of 120/277 V ac.
   3. Wall with universal junction box adaptor.
   4. UV stable thermoplastic housing, rated for damp locations.
   5. Two LED lamp heads.
   6. Internal emergency power unit.

C. Remote Emergency Lighting Units:
   1. Emergency Lighting Unit: As indicated on Interior Lighting Fixture Schedule.
   2. Wall with universal junction box adaptor.
   3. UV stable thermoplastic housing, rated for damp locations.
   4. One LED lamp heads.
   5. External emergency power unit.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Operating at nominal voltage of 120/277 V ac.
   2. LEC (Light Emitting Capacitor): Solid state panel type, 3/8 watt power draw for single face, non-battery unit, universal input power.
   3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
   4. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
   5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
      a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
   8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

C. Self-Luminous Signs:
   1. Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 15 years.
   2. Use strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.
2.5 MATERIALS
A. Metal Parts:
1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.
B. Doors, Frames, and Other Internal Access:
1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
4. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
5. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

2.6 METAL FINISHES
A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT COMPONENTS
A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 EXECUTION
3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Comply with NECA/IESNA-500, “Recommended Practice for Installing Indoor Commercial Lighting Systems.”
B. Comply with NECA 1.
C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
D. Install lamps in each luminaire.
E. Supports:
1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:
1. Attached to a minimum 20-gage backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling Grid Mounted Luminaires:
1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL
A. Perform the following tests and inspections:
   1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

E. Advance Notice: Give dates and times for field tests.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Corroded Fixtures: Replace during warranty period.

3.5 STARTUP SERVICE
A. Perform startup service:
   1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING
A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
   1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
      a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   2. Conduct short-duration tests on all emergency lighting.

B. Adjust aimable luminaires according to the directions shown on lighting drawings or per Owner's direction.

3.7 CLEANING
A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.
3.8  INTERIOR LUMINAIRE SCHEDULE
   A.  See drawings for Luminaire Schedule.

END OF SECTION
SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Communications equipment coordination and installation.
   2. Common communications installation requirements.
   3. Demolition.
   4. Cutting and patching for electrical construction.
   5. Touchup painting.
   6. Disposition of existing materials and equipment.

1.2 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.
C. Comply with State and /or City Code requirements.
D. All materials shall meet the standards of the following institutes where applicable:
   1. National Fire Protection Association (NFPA)
   2. American Society of Testing Materials (ASTM)
   3. American National Standards Institute (ANSI)
   4. National Electrical Manufacturer’s Association (NEMA)
   5. Institute of Electrical and Electronic Engineers (IEEE)

1.3 DISCONTINUED PRODUCTS
A. The Engineer shall be notified as soon as possible of any discontinuance of production of any specified equipment and/or devices as discovered by the low voltage (Division 27) contractor; however, the low voltage (Division 27) contractor shall not be relieved from furnishing an Engineer approved alternate equipment and/or device of comparable design and quality without any extra cost to the Owner.

1.4 COORDINATION
A. Coordinate arrangement, mounting, and support of communications equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. Connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 “Access Doors and Panels.”
D. Coordinate chases, slots, inserts, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Core drilling through post-tensioned slab: The existing post-tensioned slabs contain post-tensioned tendons that must not be damaged or broken. No nailing, drilling, cutting or other disruption to the slab is allowed without prior written approval by the structural engineer. Contractor shall positively locate the existing tendons and submit to the structural engineer for approval a written procedure, including plans showing existing tendon locations and proposed disruption of the slab.

E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

F. Coordinate communication service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services.

G. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.5 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. All devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.6 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, re-location, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.0 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.1 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078400 "Firestopping."

3.2 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Reroute communication cables as required to serve equipment not in the demolition area.

C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

D. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

E. Remove demolished material from Project site.

F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

H. Assume that existing equipment and fittings indicated to be reused are in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling.

I. Fittings and other equipment removed and to be used shall be cleaned before reinstallation.

J. Added Cables: All cables added shall be coordinated with existing to remain. Where additional cables are added, identify cables per the system as exists in the facility.

K. All material and equipment which is noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the owner and stored where directed on the site.

L. Remove abandoned low voltage wiring. All wiring disconnected on one or both ends is considered abandoned unless tagged and labeled “future” or “spare”. Verify with Owner any cabling connected on both ends is still in use prior to removal.

3.3 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.4 FIELD QUALITY CONTROL
A. Inspect installed components for damage and faulty work, including the following:
   1. Firestopping.
   2. Electrical demolition.
   3. Cutting and patching for electrical construction.
   4. Touchup painting.

3.5 REFINISHING AND TOUCHUP PAINTING
A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000 "Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING AND PROTECTION
A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.7 COMMUNICATIONS SERVICE OUTAGE AND ENERGIZATIONS
A. Owner Approval: Communications service outages or energizations required shall be approved by the Owner before outages or energization. Outages shall be scheduled at the convenience of the Owner.
B. Written Request: Requests for outages and energizations shall be submitted in writing to the Owner for approval at the earliest possible date and in no case later than 14 days prior to the outage and/or energization.
C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hour's notice has been given by the Owner.
D. Schedules: A minimum of two (2) weeks before the first outage, submit a schedule of proposed sequence of the communications service's outages and energizations. This schedule shall show construction energizations and shall include any weekend work. The schedule shall list the work to be completed during and between each outage.
E. Minimize outages on the Owner's communications systems and employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary.
F. Before submitting any energization and/or outage requests, provide the owner with evidence that the following requirements have been met:
1. All required equipment and material are on the job site. All related installations that can be worked on without an energization and/or outage are complete, tested, available for inspection, and ready for service.

2. All shop drawings, test reports, installation data, and operational data have been submitted and approved.

3. The energizing and outage schedule have been submitted and approved.

END OF SECTION
SECTION 27 05 13
COMMUNICATIONS SERVICES

PART 1 GENERAL

1.1 DESCRIPTION
A. This section includes provisions for interior technology systems as indicated on the drawings or as specified herein. Provide materials, labor, equipment and supervision to install technology systems.
B. Codes and standards determine requirements. Contract documents and manufacturer warrantee requirements that exceed the codes and standards are the responsibility of the installing contractor.

1.2 QUALITY ASSURANCE
A. Technology work shall be in accordance with the following codes and agencies. Refer to the most recent adopted version.
   4. Occupation Safety and Health Administration (OSHA).
   5. State and Municipal ordinances.
   6. Americans with Disabilities Act (ADA).
   8. International Conference of Building Officials (ICBO).
B. Material and Installation Standards: Provide new material and conform to the standards where such have been established for the particular material and installation in question. Publications and Standards of the organization listed below are applicable to materials and installation specified herein. Refer to the most recent adopted version.
   1. American Society for Testing and Materials (ASTM)
   2. Underwriters' Laboratories, Inc. (UL)
   3. National Electrical Manufacturer Association (NEMA)
   4. Insulated Cable Engineers Association (ICEA)
   5. Institute of Electrical and Electronic Engineers (IEEE)
   6. National Fire Protection Association (NFPA)
   7. American National Standards Institute (ANSI)
   8. Electrical Testing Laboratory (ETL)
   9. Edison Electric Institute (EEI)
   10. National Board of Fire Underwriters (NBFU)
   11. International Standards Organization (ISO)
   12. Federal Communications Commission (FCC)
   15. TIA/EIA-526-14-C – Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedure - Part 4-1: Installed cable plant - Multimode attenuation measurement.
23. ANSI/TIA/EIA-598-D – Optical Fiber Cable Color Coding.
28. ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
33. TIA/EIA IS-729 – Technical Specifications for 100 Ohm Screened Twisted-Pair Cabling.
34. ANSI/NECA/BICSI 568 Standard for Installing Commercial Building Telecommunications Cabling.

C. Installation Methodology: Conform to the publications where such have been established for the particular installation in question. Publications of the organization listed below are applicable to the installation specified herein. Refer to the most recent adopted version.

D. Definition of Terms
   1. Refer to individual sections
   2. Newton’s Telecom Dictionary

1.3 CONTRACTOR QUALIFICATIONS
   A. A minimum of 5 years’ experience in the installation and service of voice/data cabling communications systems on projects of comparable size and scope.
   B. Registered with the equipment manufacturer(s) as franchised reseller of registered systems and serve as the installing contractor and ongoing registered service provider.
   C. Registered Communications Distribution Designer (RCDD) certified by the Building Industry Consulting Service International (BICSI).
   D. Installation personnel trained in the proper installation of extended performance data and voice cable, prior to installation, by outside training course or in-house training program.
   E. Alarm and Communications License furnished by the Minnesota State Board of Electricity.

1.4 PERMITS
   A. Secure and pay for licenses and permits required by the State and Municipality before work is started. Observe requirements of permits and licenses.
   B. Schedule inspection of work and installations by the authority having jurisdiction.

1.5 SUPERVISION
   A. Installations shall be made by persons licensed and skilled in the trade and shall be done under the supervision of a BICSI Registered Communications Distribution Designer (RCDD).
1.6 WARRANTY
A. Refer to the General Conditions and individual sections, for warranty of work under Division 27.
B. Warrant to the owner and Architect the following:
   1. Materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents.
   2. The Work will be free from defects not inherent in the quality required or permitted.
   3. The Work will conform to the requirements of the Contract Documents.
   4. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective.
   5. Warranty excludes remedy for damage or defect caused by abuse, modifications not executed under this Contract, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.
   6. If required by the Architect, furnish satisfactory evidence as to the kind and quality of materials and equipment.

1.7 DRAWINGS
A. The Technology drawings indicate the arrangements of technology equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of technology equipment with structural system and mechanical equipment and access thereto.
B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Technology plans.
C. Bring discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.
D. Equipment layout is based on one manufacturer’s product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.8 SUBMITTALS
A. Pre-Construction
   1. List of Materials and Subcontractors:
      a. Refer to Division 01 for submittal requirements.
   2. Schedule of Values:
      a. Refer to Division 01 for submittal requirements.
      b. Provide a schedule of values for the technology contract work specified under Division 27. Include separate labor and material itemization for each line item requested.
      c. Provide the following line items as a minimum level of itemization:
         1) Horizontal Cabling.
      d. The itemized schedule of values, above, will be used to determine project completion and progress for payment requests, including overhead and profit for each itemization. Schedule of values must be submitted and approved prior to first pay request.
   3. Shop Drawings and Product Data:
      a. Submit for review, shop drawings and product data of materials and equipment to be incorporated in the work. Support submittals with descriptive material, catalog cut sheets, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements. Provide complete electrical characteristics for equipment.
      b. Refer to the individual sections for identified equipment and materials for which submittals are required.
      c. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES section for required procedures.
d. Neatly bound in a three ring or comb type binder, with protective covers. Identify the project, the site, system, date and vendor name on the cover.
e. Consisting of, but not be limited to the following items:

1) Title sheet showing the Project Name, Project Location, Specification Title and Specification number, Contractor's name, address, phone number, BICSI RCDD registration stamp with signature and date submitted. Provide clear area on the title sheet for shop drawing review stamps.

2) Organize submittal into logical sections and provide table of contents.

3) Material list showing quantity, manufacturer and description of each item being furnished.

4) On datasheets with multiple products, indicate which product is provided under this project.

5) Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

f. Submit documents as a single package per site.

g. Submit within 2 weeks after award of contract.
h. The Contractor must neither order equipment nor proceed with installation until the Architect approves shop drawings.

B. Close-Out

1. Record Documents:
   a. Refer to Division 01 for record documents and related submittals.

2. Operation and Maintenance Data and Instructions
   a. Refer to Division 01 for detail requirements.
   b. Printed Material: Provide required printed material for binding in operation and maintenance manuals.

1.9 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions, which are not detailed on the drawings, must still be restored to their original condition.

PART 2 PRODUCTS

2.1 MATERIALS

A. Materials shall be new.

B. Furnish materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the products of one manufacturer.

D. UL listed material shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.

E. Work such as painting, patching, welding or carpentry related to the work of this Division shall be performed by the appropriate trade experienced in that work, but shall be provided for under this Division.
PART 3 EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and supplier's recommendations, and in a manner to prevent damage to materials. Store packed materials in original undamaged condition with manufacturer's labels and seals intact. Containers, which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.

B. Material shall be stored in an enclosed, dry building or trailer. Provide areas for general storage. Provide temperature and/or humidity controls where applicable. Equipment stored other than as specified above shall be removed from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.2 EQUIPMENT INSTALLATION

A. Existing racks will be re-used as is.

B. Equipment: Active network equipment will be provided by Hennepin County.

3.3 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Firestopping."

3.4 DEMOLITION

A. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove existing cabling.

D. Remove demolished material from Project site.

E. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

F. Carefully remove and deliver to the owner or store where directed on the site, material and equipment noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated.

3.5 REFINISHING AND PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING AND PROTECTION
A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
C. Clean accessible elements with compressed air (less than 15 PSI) and vacuum clean the interior of enclosures.
D. Periodically remove waste and rubbish from project site and maintain order. Premises shall be left clean and free of debris and unused construction materials prior to owner acceptance.

3.7 CUTTING AND PATCHING
A. Do not endanger the stability of the structure by cutting, drilling or otherwise modifying the structural members of the building. Direct all requests for structural modifications to the Architect for approval. Proceed with these modifications only as directed by the Architect.
B. Cutting and patching requirements will be modified only if General Construction Specifications and drawings specifically state that certain portions or all cutting and patching required for each of the various trades is to be performed by the General Contractor.
C. Refer to General Construction Specifications for execution and requirements for patching and painting and comply with applicable provisions as to materials and quality of installation.
D. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit installations. Perform cutting by skilled mechanics of trades involved.
E. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 TECHNOLOGY SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE
A. Testing:
   1. Refer to the individual specification sections for test requirements.
   2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Architect for approval.
   3. Test technology systems for compliance with the specifications.
B. Manufacturer's Certifications:
   1. Submit the technology systems design documentation for review by a representative of the manufacturer to verify compliance with the manufacturer's recommendations and system operation. The manufacturer shall submit certification that the system has been reviewed and the design is in accordance with the manufacturer's recommendations.
   2. Submit the technology systems installation and operation for review by a representative of the manufacturer to verify compliance with the manufacturer's recommendations and system operation. The manufacturer shall submit certification that the system has been reviewed and the installation is in accordance with the manufacturer's recommendations.
   3. Provide manufacturers certifications for the following systems:
      a. Structured Cabling.
C. Design Authority Assistance:
   1. Remove equipment covers for inspection of internal cabling.
   2. Remove accessible ceilings for inspection of equipment installed above ceilings.
3. Demonstrate operation of equipment and systems.
4. Remove manhole covers, pump manholes dry and provide a ladder for inspection of interior of manholes.
5. Provide authorized representatives of the manufacturers to demonstrate to the compliance with the specifications of the respective systems during or prior to the final inspection at a time designated by the Architect. Refer to the specific specification section for additional testing requirements.
6. Representatives of the following systems are required for demonstrations:
   a. Copper Horizontal Cabling
   b. Structured Cabling
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Metal conduits and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Nonmetallic wireways and auxiliary gutters.
   5. Nonmetallic surface pathways.
   6. Tele-power poles.
   8. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS
A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.
D. RTRC: Reinforced thermosetting resin conduit.

1.3 ACTION SUBMITTALS
A. Product data for the following:
   1. Surface pathways
   2. Wireways and fittings.
   3. Tele-power poles.

1.4 INFORMATIONAL SUBMITTALS
A. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS AND FITTINGS
A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   3. Anamet Electrical, Inc.
   4. Bridgeport Fittings, Inc.
   5. Electri-Flex Company.
   7. Picoma Industries.
   8. Republic Conduit.
   9. Robroy Industries.
  10. Southwire Company.
  12. Western Tube and Conduit Corporation.

C. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-D.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. ARC: Comply with ANSI C80.5 and UL 6A.

F. IMC: Comply with ANSI C80.6 and UL 1242.

G. PVC-Coated Steel Conduit: PVC-coated GRC or IMC.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch (1 mm), minimum.

H. EMT: Comply with ANSI C80.3 and UL 797.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Fittings for EMT:
      a. Material: Steel or Zinc die cast.
      b. Type: Setscrew or compression.
   2. EMT Fitting Materials:
      a. All Zinc materials shall be ASTM B86 certified
      b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
      c. All Steel shall be SAE 1050.
   3. EMT Fitting Design:
      a. Zinc die cast components shall be ball burnished.
      b. Steel parts shall be zinc plated for corrosion protection.
      c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
      d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
      e. All fitting throat diameters shall be smooth with no sharp edges or slag.
      f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
      g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.
   4. Transition Fittings:
      a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one raceway type to another must be UL listed for that application.
   5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   4. Square D.
C. General Requirements for Metal Wireways and Auxiliary Gutters:
   1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
   3. Comply with TIA-569-D.
D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
E. Wireway Covers: Hinged type unless otherwise indicated.
F. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE METAL PATHWAYS
A. Description: Galvanized steel with snap-on covers, complying with UL 5.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Mono-Systems, Inc.
   2. Niedax-Kleinhuis USA, Inc.
   3. Panduit Corp.
   4. Wiremold / Legrand.
C. Finish: Prime coated, ready for field painting.
D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
E. Comply with TIA-569-D.

2.4 HOOKS
A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. B-Line
   2. Mono Systems, Inc
   3. Panduit Corp.
   4. Pentair
   5. Wiremold/Legrand
C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
D. Comply with TIA-569-D.
E. Galvanized steel.
F. J or U shape.

2.5 BOXES, ENCLOSURES, AND CABINETS
A. Description: Enclosures for communications.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
5. Hoffman.
6. Lamson & Sessions; Carlon Electrical Products.
7. Milbank Manufacturing Co.
8. Molex; Woodhead Brand.
12. RACO; Hubbell.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
17. Wiremold / Legrand.

C. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with TIA-569-D.
   2. Boxes, enclosures and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
   3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
   4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
   5. Gangable boxes are prohibited.

D. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

F. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round.
   1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

PART 3 EXECUTION

3.1 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Pathway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC or IMC.
6. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

B. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (25 mm).

C. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression, steel or Zinc die-cast metal fittings. Comply with NEMA FB 2.10 and UL514B.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface pathways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA/BICSI 568.
   3. TIA-569-D.
   4. NECA 101
   5. NECA 102.
   6. NECA 105.
   7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

E. Complete pathway installation before starting conductor installation.

F. Arrange stub-ups so curved portions of bends are not visible above finished slab.

G. Install no more than the equivalent of two 90-degree bends and no more than 100 feet (30 meters) of length in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

H. Conceal rigid conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

I. Support conduit within 12 inches (300 mm) of enclosures to which attached.

J. Pathways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed thread-less fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from nonmetallic conduit and fittings to GRC or IMC and fittings before rising above floor.

K. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

R. Surface Pathways:
   1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
   3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

T. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building or structure.
   3. Where otherwise required by NFPA 70.

U. Hooks:
   1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
   2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
   3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
   4. Space hooks no more than 5 feet (1.5 m) o.c.
   5. Provide a hook at each change in direction.
V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain-tight connection between box and cover plate or supported equipment and box.

X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

AA. Set metal floor boxes level and flush with finished floor surface.

BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

CC. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

DD. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

EE. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

FF. Set outlet boxes for flush mounted devices to within 1/8" of finished wall.

GG. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8" of finished wall.

HH. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION
SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Color and legend requirements for labels.
   2. Labels.
   3. Tapes.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.
B. Identification Schedule:
   1. Outlets: Scaled drawings indicating location and proposed designation.
   2. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Comply with NFPA 70 and TIA 606-B.
B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS
A. Equipment Identification Labels:
   1. Black letters on a white field.

2.3 LABELS
A. Self-Adhesive Wraparound Labels: Write-on, 3-mil- (0.08-mm-) thick, polyester flexible labels with acrylic pressure-sensitive adhesive.
   1. Manufacturers:
      a. A’n D Cable Products
      b. Brady Corporation
      c. Brother International Corporation
      d. Emedco
      e. Grafolast Wire Markers
      f. Ideal Industries, Inc.
      g. LEM Products Inc.
      h. Marking Services, Inc.
      i. Panduit Corp.
      j. Seton Identification Products
   2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
   3. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.
   4. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
PART 3 EXECUTION

3.1 PREPARATION
A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION
A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
B. Install identifying devices before installing acoustical ceilings and similar concealment.
C. Verify identity of each item before installing identification products.
D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
E. Self-Adhesive Wraparound Labels:
   1. Secure tight to surface at a location with high visibility and accessibility.
   2. Provide label 6 inches (150 mm) from cable end.
F. Self-Adhesive Labels:
   1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

3.3 IDENTIFICATION SCHEDULE
A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
C. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
   1. Telecom room designation.
   2. Colon.
   3. Faceplate number.
D. Equipment Room Labeling:
   1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.

3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
   a. Room number being served.
   b. Colon.
   c. Faceplate number.

E. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
   1. Room number.
   2. Colon.
   3. Faceplate number.

F. Equipment Identification Labels:
   1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.
   2. Equipment to Be Labeled:
      a. Communications cabinets.

END OF SECTION
SECTION 27 15 13
COMMUNICATIONS COPPER HORIZONTAL CABBING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Category 6 twisted pair cable channel, permanent link for voice and data.
   2. Category 6a twisted pair cable channel, permanent link for voice and data.
   3. Twisted pair cable hardware, including plugs and jacks.
   5. Cable management system.
   8. Source quality control requirements for twisted pair cable.
B. Related Requirements:
   1. Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
   2. Section 27 05 36 "Cable Trays for Communications Systems" for cable trays and accessories.
C. Support the following network topologies:
   1. Analog Voice Circuits
   2. Digital Voice Circuits
   3. ISDN BRI
   4. DS-1
   5. DS-3
   6. Fractional T-1’s
   7. T-3’s
   8. Ethernet 10/100/1000Base-TX and 10GBASE-TX standards.
D. Registered with the manufacturers of the equipment as an installed system that meets industry standards for structured voice and data cabling systems. Manufacturers' warrantees for a minimum period of 15 years for proper operation of any communications protocol designed to operate over the specified cabling system.
E. Documentation of the voice and data cabling system test results recorded in cable management software.
F. Tested and documented for reference by the Owner.

1.2 DEFINITIONS
A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
B. EMI: Electromagnetic interference.
C. FTP: Shielded twisted pair.
D. F/FTP: Overall foil screened cable with foil screened twisted pair.
E. F/UTP: Overall foil screened cable with unscreened twisted pair.
F. IDC: Insulation displacement connector.
G. LAN: Local area network.
H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
J. RCDD: Registered Communications Distribution Designer.
K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
M. S/FTP: Overall braid screened cable with foil screened twisted pair.
N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
O. UTP: Unscreened (unshielded) twisted pair.

1.3 EXISTING CONDITIONS
A. Remove all cables located within the confines of the building back to the source except for service provider cables.

1.4 COPPER HORIZONTAL CABLE DESCRIPTION
A. Horizontal cable cabling system shall provide interconnections between the existing rack and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. TIA-568-D.1 requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.
B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the equipment outlets to the station equipment.
C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.
D. The voice and data cabling system shall support the future installation and connection of the following equipment. (Equipment not in contract.)
   1. Active data equipment at the Racks.
   2. Telephone equipment at the Racks.
   3. Telephone equipment at the Voice Backboards.
   5. Telephones at the Workstation and Wall Telephone Outlets.
   6. Wireless Local Area Network.
E. Patch Cord installation and Cross-Connect Cable installation not in contract.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: Reviewed and stamped by RCDD.
   1. Title sheet showing the Project Name, Project Location, Specification Title and Specification number, contractor's name, address, phone number, RCDD Registration Stamp with signature and date submitted. Clear area shall be provided on the title sheet for shop drawing review stamps.
2. Organize submittal into logical sections and provide table of contents.
3. Provide itemized bill of materials indicating model number and quantity for each product.
4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
6. Provide certificates of training for Voice and Data premise cabling, per ANSI/TIA/EIA 568, for supervisors of installation personnel. Certificates shall be acceptable from a manufacturer of the equipment listed or an independent training company.
7. Manufacturers' catalog sheets with complete technical data for each item being furnished.
8. Confirmation that products are registered components for the manufacturer's warranty.
10. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
11. Cabling administration Drawings and printouts.
12. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
   a. Telecommunications pathways.
   b. Telecommunications system access points.
   c. Telecommunications conductor drop locations.
   d. Typical telecommunications details.

C. Twisted pair cable testing plan.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
B. Product Certificates: For each type of product.
C. Source quality-control reports.
D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS
A. Maintenance Data: For splices and connectors to include in maintenance manuals.
B. As-Built/Record Drawings:
   1. Two sets in hard copy format and two sets in electronic Auto CAD format, including bid submittals, revised shop drawing and product data showing:
      a. Final configuration of the system
      b. Final layouts of terminal boards, racks and cabinets
      c. Floor plans showing cable routes and workstation outlet locations with horizontal cable ids.
      d. Record of cross-connection configuration.
      e. Test results of horizontal cables listed by each Telecom room and horizontal cable id.
   2. Hard copy information shall be in typewritten or printed form in a useful format.

1.8 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faceplates: One of each type.
   2. Jacks: Ten of each type.
1.9 QUALITY ASSURANCE
A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
B. Testing Agency Qualifications: Testing Agency must have personnel certified by BICSI on staff.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING
A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.

1.11 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION
A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 PRODUCTS
2.1 PERFORMANCE REQUIREMENTS
A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-D.1, when tested according to test procedures of this standard.
B. Supply products, defined as part of the horizontal cabling system configuration, by a single manufacturer and listed cable partner.
C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
D. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS
A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
   1. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.
C. RoHS compliant.
2.3 CATEGORY 6 TWISTED PAIR CABLE
A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMP NETCONNECT; a TE Connectivity Ltd. company
   2. Belden CDT Networking
   3. Berk-Tek Leviton; a Nexans/Leviton alliance
   4. CommScope, Inc.
   5. Draka USA.
   6. General Cable; General Cable Corporation
   7. Hitachi Cable America Inc.
   8. Mohawk; a division of Belden Networking, Inc.
   9. Superior Essex Inc.
   10. SYSTIMAX Solutions; a CommScope, Inc. brand.
D. Conductors: 100-ohm, 23 AWG solid copper.
E. Shielding/Screening: Unshielded twisted pairs (UTP).
F. Cable Rating: Plenum.
G. Jacket (Color):
   1. Voice - Gray thermoplastic.
   2. Data 1 - Blue thermoplastic.

2.4 CATEGORY 6A TWISTED PAIR CABLE
A. Description: Four-pair, balanced-twisted pair cable with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMP NETCONNECT; a TE Connectivity Ltd. company
   2. Belden CDT Networking
   3. Berk-Tek Leviton; a Nexans/Leviton alliance
   4. CommScope, Inc.
   5. Draka USA.
   6. General Cable; General Cable Corporation
   7. Hitachi Cable America Inc.
   8. Mohawk; a division of Belden Networking, Inc.
   9. Superior Essex Inc.
   10. SYSTIMAX Solutions; a CommScope, Inc. brand.
C. Standard: Comply with TIA-568-D.2 for Category 6a cables.
D. Conductors: 100-ohm, 23 AWG solid copper.
E. Shielding/Screening: Unshielded twisted pairs (UTP).
F. Cable Rating: Plenum.

2.5 TWISTED PAIR CABLE HARDWARE
A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMP NETCONNECT; a TE Connectivity Ltd. company
   2. Belden CDT Networking
3. Berk-Tek Leviton; a Nexans/Leviton alliance
4. CommScope, Inc.
5. Draka USA.
6. General Cable; General Cable Corporation
7. Hubbell Premise Wiring
8. KRONE Incorporated
9. Leviton Manufacturing Company
10. Mohawk; a division of Belden Networking, Inc.
11. Molex Premise Networks
12. Panduit Corp
13. Siemon Co. (The)
14. Superior Essex Inc.
15. SYSTIMAX Solutions; a CommScope, Inc. brand.
16. 3M

C. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with the performance requirements of Category 6 (exception: wireless access point outlets) and Category 6a (provide 6a for wireless access point outlets only unless specifically noted otherwise).
   2. Comply with TIA-568-D.2, IDC type, with modules designed for punch-down caps or tools.
   3. Cables shall be terminated with connecting hardware of same category or higher.
   4. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

D. Field Configured Twisted Pair Patch Panel:
   1. IDC type, using modules designed for punch-down caps or tools.
   2. IDC Terminal Block Modules: Integral with connector bodies, including plugs and jacks.
   3. Angled face.
   4. Modular panels housing multiple numbered jack units with IDC-type connectors at each jack.
   5. Number of panels: As indicated on drawings.
   6. Number of ports: As indicated on drawings.
   7. Number of Jacks: One for each four-pair UTP cable, plus spares and blank positions adequate to satisfy specified expansion criteria.
   8. Labeling: White background designation strips with clear plastic covers integral to patch panel.
   9. Rear horizontal cable management.

E. Preconfigured Twisted Pair Patch Panel:
   1. IDC type, using modules designed for punch-down caps or tools.
   2. Angled face.
   3. Modular panels housing multiple numbered jack units.
   4. Number of panels: As indicated on drawings.
   5. Number of ports: As indicated on drawings.
   6. Number of Jacks: One per port.
   7. Category 6A rated.
   8. Labeling: White background designation strips with clear plastic covers integral to patch panel.
   9. Rear horizontal cable management.

F. Pre-wired 25 Pair Twisted Pair Patch Panel:
   1. 50 position RJ21X Telco Connector
   2. Angled face.
   3. Modular panel housing multiple numbered jack units.
   4. Number of panels: As indicated on drawings.
   5. Number of ports: As indicated on drawings.
   6. Number of Jacks: One per port
   7. Category 6 enhanced, rated.
   8. Labeling: White background designation strips with clear plastic covers integral to patch panel.
9. Rear horizontal cable management.
11. Termination: T568A, T568B, 2 pins/jack to match PBX requirements.

G. Plugs and Plug Assemblies:
   1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Designed to snap-in to a patch panel or faceplate.
   4. Category 6 or 6A.
   5. Marked to indicate transmission performance.
   7. Colors:
      a. Voice - Owner selected thermoplastic.
      b. Data 1 - Orange
      c. Preconfigured and pre-wired 25 pair twisted pair patch panel – Black.

I. Workstation Outlets:
   1. Wall
      a. Single angled jack or multiple angled jacks as indicated on drawings.
      b. Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
      c. Faceplate: Plastic.
      d. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
      e. Labeling: White background designation strips with clear plastic covers integral to faceplate.
      f. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.
   2. Underfloor box.
      a. Single or multiple jacks as indicated on drawings.
      b. Single gang faceplate.
      c. Faceplate: Stainless steel.
      d. Labeling: White background designation strips with clear plastic covers integral to faceplate.
      e. Mounting: Surface in outlet box.
   3. Surface raceway.
      a. Single angled jack or multiple angled jacks as indicated on drawings.
      b. Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
      c. Faceplate: Plastic.
      d. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
      e. Labeling: White background designation strips with clear plastic covers integral to faceplate.
   4. Furniture. Type A.
      a. Single jack or multiple jacks as indicated on drawings.
      b. Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
      c. Faceplate: Plastic.
      d. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
      e. Labeling: White background designation strips with clear plastic covers integral to faceplate.
      f. Non-metallic device box 4-3/4” (L) x 3” (W) x 2-3/4” (D).
      g. Mounting: Flush on raceway cover, Surface on raceway cover, On shelf within furniture partition.
5. Furniture. Type B.
   a. Single jack or multiple jacks as indicated on drawings.
   b. Modular furniture adapter to match furniture manufacturer.
   c. Labeling: White background designation strips with clear plastic covers integral to faceplate
   d. Mounting: Flush in modular furniture.
6. Furniture. Type C.
   a. Single jack or multiple jacks as indicated on drawings.
   b. Integral plastic base plate and cover.
   c. Labeling: Vinyl adhesive tape.
   d. Color: Owner selected.
   e. Mounting: Surface.
7. Ceiling.
   a. Single jack.
   b. Single gang faceplate.
   c. Faceplate: Stainless steel.
   d. Labeling: White background designation strips with clear plastic covers integral to faceplate.
   e. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.
   a. Single jack or multiple jacks as indicated on drawings.
   b. Integral plastic base plate and cover.
   c. Labeling: Vinyl adhesive tape.
   d. Color: Owner selected.
   e. Mounting: Surface on structure above accessible ceiling tiles.
J. Card Access Control System Controller Panel Outlets:
   1. 12” coil of UTP cable inside of Controller Panel housing terminated with 8-position modular plug.
      Coordinate specific termination location with Security Contractor.
   2. Labeling: Vinyl adhesive tape.
   3. Refer to the Telecom Room enlarged plans for Controller locations.
K. Video Surveillance Camera Outlets:
   1. Wall or Ceiling
   2. 12” coil of UTP cable inside outlet box terminated with 8-position modular plug.
   3. Labeling: White background designation strips affixed to inside surface of outlet box.
   4. Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.
   5. Refer to the E4xx series Electrical Systems drawings for locations and additional information.
L. Floor Box Outlets.
   1. Single jack or multiple jacks as indicated on drawings.
   2. Mount in service plate integral to floor box.
   3. Service plate and jack arrangement with adequate clearances to comply with TIA/EIA industry standards for maintaining proper bend radii on UTP horizontal cables behind jacks.
M. Poke-Thru Outlets.
   1. Multiple jacks.
   2. Mount in service plate integral to poke-thru.
N. Voice Wall Outlets:
   1. Single jack.
   3. Faceplate: Stainless steel or plastic with mounting posts for wall mount telephone.
   4. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
   5. Mounting: Flush, in finished areas unless indicated otherwise, surface in unfinished areas.
O. Legend:
   1. Machine printed, in the field, using adhesive-tape label.
   2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 IDENTIFICATION PRODUCTS
   A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
   B. Cable Markers: Vinyl wraparound adhesive tape markers, machine printed with black lettering on white background.
   C. ½” wide vinyl adhesive tape machine printed with 3/8” high black lettering on white background.

2.7 GROUNDING
   A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors, connectors, and grounding busbars.
   B. Comply with TIA-607-B.

2.8 SOURCE QUALITY CONTROL
   A. Testing Agency: Engage a qualified testing agency to evaluate cables.
   B. Factory test cables on reels according to TIA-568-D.1.
   C. Factory test twisted pair cables according to TIA-568-D.2.
   D. Cable will be considered defective if it does not pass tests and inspections.
   E. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 WIRING METHODS
   A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
      1. Install plenum cable in environmental air spaces, including plenum ceilings.
      2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
   B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
   C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS
   A. Comply with Section 270528 "Pathways for Communications Systems."
   B. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES
   A. Comply with NECA 1 and NECA/BICSI 568.
B. General Requirements for Cabling:
   1. Comply with TIA-568-D.0, TIA-568-D.1, and TIA-568-D.2.
   3. Install 110-style IDC termination hardware unless otherwise indicated.
   4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
   5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   6. Provide continuous lengths of horizontal cable from patch panel termination to jack termination without splices.
   7. Conceal cabling except in unfinished spaces.
   8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
   10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI's "Information Transport Systems Installation Methods Manual" (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools. Provide tie wraps to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommendations.
   11. Install cable without damaging conductors, shield, or jacket.
   12. Do not bend cable in handling or in installing to smaller radii than minimums recommended.
   13. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
   14. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
   15. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
   17. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
      a. Pull cables simultaneously if more than one is being installed in the same raceway.
      b. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
      c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway.
   18. Provide cover plates for outlet boxes including outlets in modular furniture. Provide blank plates for boxes that are indicated on the plans but are not indicated to receive outlet faceplates and jacks.
   19. Provide weatherproof cover for all workstation outlets indicated as weatherproof.
   20. Seal cable entry on underfloor workstation outlets.
   21. Install furniture workstation outlet on owner furnished furniture.
   22. Install furniture workstation outlet in owner-furnished modular furniture.
   23. Provide service plate and faceplate for mounting of jacks in floor boxes. Floor boxes provided by Division 26.

C. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1219 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

E. Equipment Rooms and Telecom Rooms
1. Mount connectors and terminal equipment hardware on backboards, and racks unless otherwise indicated.
2. Group connecting hardware for cables into separate logical fields as indicated on drawings.
3. Use patch panels for data and cross connect panels for voice to terminate cables entering the space, unless otherwise indicated.
4. Provide supporting connections from racks to structural ceiling or adjacent wall. Anchor rack bases to structural floor.
5. Provide one spool of each color combination and type of cross-connect cable with wall brackets in each telecommunications room and equipment room. Locate wall bracket [adjacent to, on] voice cross-connect backboard.
6. Provide 25’ service loop on horizontal voice cables at the telecom room end of the cables for future termination in the data racks.

F. Outlet configuration:
1. Provide 1 voice jack and 2 data jacks at each workstation voice/data outlet unless noted otherwise.
2. Provide 1 data jack at each ceiling workstation data outlet unless noted otherwise.
3. Provide 1 voice jack and 2 data jacks at each floor box voice/data outlet unless noted otherwise.
4. Provide 1 voice jack and 2 data jacks at each poke-thru voice/data outlet unless noted otherwise.
5. Provide 1 voice jack at each voice wall outlet unless noted otherwise.
6. Provide 1 data jack at each Wireless LAN access point outlet unless noted otherwise.
7. Provide 1 data jack at each Video Surveillance Security Camera outlet unless noted otherwise.

G. Jack terminations:
1. Terminate jacks and furnish patch cords to the T568A pin/pair assignment, unless noted otherwise.

H. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING
A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-D, Annex A, "Firestopping."
D. Provide conduit sleeves through penetrations of fire rated walls and floor/ceiling penetrations.

3.5 GROUNDING
A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter and Section 270526 "Grounding and Bonding for Communications Systems."
C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 3/0 grounding electrode conductor from grounding bus bar to suitable electrical building ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
E. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.
F. Ground equipment racks and cable tray to Telecommunications Grounding Busbar.
G. Install a copper bonding jumper from each section or fitting of the cable tray system to the next section or fitting of the cable tray system.
H. Bond cable shields, screens and drain conductors to Telecommunications Grounding Busbar.

3.6 IDENTIFICATION
A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Administration Class: Class 2.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.
C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:
   1. Visually inspect twisted pair cabling jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-D.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test 100% of voice and data, UTP horizontal cables for performance to TIA/EIA-568-D.2, Category 6 enhanced or 6A, permanent link, channel requirements. The test instrument shall conform to the TIA/EIA-1152 Level II-e, measurement accuracy. Test 100% of voice and data, UTP horizontal cables for performance to TIA/EIA-568-D.2, category 6, permanent link, channel requirements. The test instrument shall conform to the TIA/EIA-1152 Level III, measurement accuracy. Test 100% of UTP horizontal cables for performance to TIA/EIA-568-D.2, augmented category 6, permanent link requirements. The test instrument shall conform to the TIA/EIA-1152 Level III-e, measurement accuracy.
   4. Test 100% of voice horizontal cables for performance to TIA/EIA-568-D.2, category 6, permanent link requirements.
   5. Replace and retest any cable that fail to pass the performance requirements.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to review the following with the Owner's maintenance personnel.
   1. Labeling system and cross-reference to documentation.
   2. Interpretation of cable test results.
   3. Review data in maintenance manuals.
   4. Warranty procedures.

B. Schedule training with Owner, through Architect, with at least seven days advance notice. Owner training to include, but not be limited to the following:
   1. Final walk-thru of all Telecom Spaces.
   2. Review of hard copy and electronic as-built drawings indicating workstation outlet locations and cable ids.
   3. Review of cable test data.

3.9 SPARES

A. Extra Horizontal Cables:
   1. Provide extra horizontal cables to locations above the ceilings for future installation to workstation outlets. Quantities of horizontal cables provided shall be sufficient to allow for a 10% growth above the initial quantity of workstation outlets indicated on drawings.
   2. Half of the total quantity of extra horizontal cables are to be of sufficient length to reach to future workstation outlets that are located the greatest distance from the Telecommunications rooms.
   3. Coil extra horizontal cables above the ceilings at locations as indicated on drawings.
   4. Terminate horizontal cables on to twisted pair patch panels in Telecommunications rooms. Leave horizontal cables unterminated at the workstation end of the cables above the ceilings.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Preamplifiers.
      2. Power amplifiers.
      3. Transfer to standby amplifier.
      5. Volume limiter/compressors.
      6. Control console.
      7. Equipment cabinet.
      8. Equipment rack.
     10. Tone generator.
     11. Monitor panel.
     12. Loudspeakers.
     15. Battery backup power unit.
     17. Pathways.

1.3 DEFINITIONS
   A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones,
      with separate amplification and switching that permit selection between paths for speaker
      alternative program signals.
   B. VU: Volume unit.
   C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for
      selective switching between different channels.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: Power, signal, and control wiring.
      1. Include plans, elevations, sections, and attachment details.
      2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances,
         method of field assembly, components, and location and size of each field connection.
      3. Console layouts.
      4. Control panels.
      5. Rack arrangements.
      7. Wiring Diagrams: For power, signal, and control wiring.
         a. Identify terminals to facilitate installation, operation, and maintenance.
         b. Single-line diagram showing interconnection of components.
         c. Cabling diagram showing cable routing.
C. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of supports and seismic restraints for control consoles, equipment cabinets and racks, and components.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
B. Qualification Data: For Installer and testing agency.
C. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Include qualification data for testing agency.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For public address systems to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 01 77 00 "Closeout Procedures" and Section 01 78 23 "Operation and Maintenance Data," include the following:
      a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
      b. Operating instructions laminated and mounted adjacent to operating console location.
      c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Microphone: Four.
   2. Microphone Desk Stand(s): Four.

1.8 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Personnel certified by NICET as Audio Systems Level II Technician.
B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
   1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Altec Lansing Technologies, Inc.
   2. Atlas Sound LP.
   3. Bogen Communications, Inc.
   5. Edwards Signaling; UTC Fire & Security.

B. Source Limitations: Obtain public address system from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:
   1. Selectively connect any zone to any available signal channel.
   2. Selectively control sound from microphone outlets and other inputs.
   3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
   4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
   5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
   6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.

2.3 SYSTEM DESCRIPTION

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with EIA/ECA-310-E.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.4 PREAMPLIFIERS

A. Preamplifier: Separately mounted.

B. Preamplifier: Integral to power amplifier.

C. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.

D. Total Harmonic Distortion: Less than 1 percent.

E. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
F. Input Jacks: Minimum of three. One matched for low-impedance microphone; one USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.

G. Minimum Noise Level: Minus 55 dB below rated output.

H. Controls: On-off, input levels, and master gain.

2.5 POWER AMPLIFIERS

A. Mounting: Rack.

B. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus a 10 percent allowance for future stations.

C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.


E. Frequency Response: Within plus or minus 3 dB from 20 to 12,000 Hz.

F. Output Regulation: Less than 2 dB from full to no load.

G. Controls: On-off, input levels, and low-cut filter.

H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.6 TRANSFER TO STANDBY AMPLIFIER

A. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

2.7 MICROPHONES

A. Paging Microphone:
   1. Type: Dynamic, with cardioid polar characteristic.
   2. Impedance: 500 ohms.
   3. Frequency Response: Uniform, 50 to 15,000 Hz.
   4. Sensitivity: Minus 70 dB.
   5. Output Level: Minus 58 dB, minimum.

2.8 VOLUME LIMITER/COMPRESSOR

A. Minimum Performance Requirements:
   1. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
   2. Reduction Ratio: Automatically vary compression ratio, and attack and release times for voice and music inputs.
      a. Compression Ratio Range: 3:1 to 10:1 minimum.
      b. Averaging Compressor Attack Time: Up to 500 milliseconds.
      c. Signal Fast Compression Attack Time: Less than 10 milliseconds.
      d. Release time: Up to 500 milliseconds.
   3. Distortion: 0.5 percent, maximum.
   4. Rated Output: Minimum of plus 14 dB.
   5. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
   6. Rack mounted.
2.9 CONTROL CONSOLE
   A. Cabinet: Modular, desktop; complying with EIA/ECA-310-E.
   B. Housing: Steel, 0.0478 inch (1.2 mm) minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
   C. Panel for Equipment and Controls: Rack mounted.
   D. Controls:
      1. Switching devices to select signal sources for distribution channels.
      2. Program selector switch to select source for each program channel.
      3. Switching devices to select zones for paging.
      4. All-call selector switch.
   E. Indicators: A visual annunciation for each distribution channel to indicate source being used.
   F. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
   G. Spare Positions: 20 percent spare zone control and annunciation positions on console.
   H. Microphone jack.

2.10 EQUIPMENT CABINET
   A. Comply with EIA/ECA-310-E.
   B. House amplifiers and auxiliary equipment at each location.
   C. Cabinet Housing:
      1. Constructed of 0.0478-inch (1.2-mm) steel, minimum, with front- and rear-locking doors and standard EIA/ECA-310-E-compliant, 19-inch (483-mm) racks.
      2. Arranged for floor or wall mounting as indicated.
      3. Sized to house all equipment indicated, plus spare capacity.
      4. Include 20 percent minimum spare capacity for future equipment in addition to space required for future DVD or CD player.
   D. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
   E. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

2.11 EQUIPMENT RACK
   A. Racks: 19 inches (483 mm) standard, complying with EIA/ECA-310-E.
   B. Power-Supply Connections: Compatible plugs and receptacles.
   C. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
   D. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
   E. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with cartridge fuse protection for rack equipment power.
   F. Service Light: At top rear of rack with an adjacent control switch.
   G. Vertical Plug Strip: Grounded receptacles, 12 inches (300 mm) o.c.; the full height of rack for public address system equipment use only.
H. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.

I. Spare Capacity: 20 percent in rack for future equipment.

2.12 TELEPHONE PAGING ADAPTER

A. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.
1. Minimum Frequency Response: Flat, 200 to 2500 Hz.
2. Impedance Matching: Adapter matches telephone line to public address equipment input.
3. Rack mounted.

2.13 TONE GENERATOR

A. Tone generator shall provide clock and program interface with public address system.
B. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
C. Pitch Control: Chimes and tone.
D. Volume Control: All outputs.
E. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
F. Mounting: Rack.

2.14 MONITOR PANEL

A. Monitor power amplifiers.
B. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
C. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
D. Mounting: Rack.

2.15 LOUDSPEAKERS

A. Cone-Type Loudspeakers:
1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: [6 inches (150 mm)] [8 inches (200 mm)] with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.
4. Rated Output Level: 8 W.
5. Minimum Dispersion Angle: 100 degrees.
6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and shop primed for field painting.

B. Horn-Type Loudspeakers:
1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.
7. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located. Provide any accessories required to maintain listing.

C. Surface mount speakers:
1. Two-way 70-Volt surface mount speaker with a dual-ported enclosure, grille, crossover network, and a concealed, lockable mounting system:
2. Driver Requirements
   a. Shall consist of a 8" (20.3 cm) polypropylene woofer
   b. Shall consist of a 1.1" (2.8 cm) silk dome tweeter
3. Performance Requirements
   a. Shall provide a frequency range of 59 Hz to 22 kHz, -10 dB below average SPL, measured on-axis in full space per IEC 60268-5
   b. Shall provide a power capacity of 90 watts (rms) continuous pink noise per IEC 60268-5 and 180 watts (rms) continuous program
   c. Shall provide a nominal sensitivity of 87 dB SPL (1 W, 1 m) measured in full space
   d. Shall provide a crossover frequency of 2.0 kHz
4. Electrical Requirements
   a. Shall support 8-Ohm, 70-Volt and 100-Volt direct connection from power amplifiers
   b. Shall provide an internal overload protection circuit
   c. Shall support one incoming and one outgoing speaker level signal on one 4-pole, 10 mm Euro-style captive screw terminal block built into 0° mounting plate
5. Shall support direct wiring of speaker or support wiring of multiple speakers using loop-through wiring terminals
6. Shall support a maximum wire gauge of 12 AWG per connection point for a single wire
7. Shall support a maximum wire gauge of 16 AWG per connection point for two wires
8. Enclosure Requirements
   a. Shall consist of a plastic, trapezoidal enclosure with molded grille and dual bass reflex ports
   b. Shall have a black or white finish
   c. Shall measure 16.5" (41.91 cm) in height when using 0° mounting plate
   d. Shall measure 11.5" (29.21 cm) in width when using 0° mounting plate
   e. Shall protrude 7.80" (19.81 cm) into environment from mounting surface when using 0° mounting plate
   f. Shall weigh 10.9 lbs (5.0 kg) per speaker when using 0° mounting plate
9. Mounting Requirements
   a. Shall include a 0° mounting plate for vertical or horizontal flush-with-the-wall installation
   b. Shall support both enclosure mounting and electrical connection as speaker is placed on mount
   c. Shall support all incoming and pass-through wiring for speaker
   d. Shall have a black or white finish to match speaker
   e. Shall include a four position 10° mounting adapter for vertical or horizontal speaker installation with 10° of tilt downward, upward, left, or right
   f. Shall have a white finish to match speaker
   g. Shall provide cable raceway access on 0° mounting plate and 10° mounting adapter for surface-mounted wiring
   h. Shall support 180° of speaker pivot in 10° detented steps with the use of optional Extron Yoke Mount Kit that is available in black or white finish
   i. Shall provide a hidden locking speaker release mechanism
10. General Requirements
   a. Shall be sold in pairs
   b. Shall meet regulatory compliances
   c. Shall comply with appropriate requirements of RoHS and WEEE
11. Shall provide five years parts and labor warranty
12. Approved device shall be the Extron SM 28, part number 60-1309-02 or 60-1309-03 with SMK P SM 26/28 mount; or approved alternates or equals.

2.16 NOISE-OPERATED GAIN CONTROLLER
A. Gain controller shall be designed to continuously sense space noise level and automatically adjust signal level to local speakers.
B. Frequency Response: 20 to 20,000 Hz, plus or minus 1 dB.
C. Level Adjustment Range: 30 dB minimum.
D. Maximum Distortion: 0.5 percent.
E. Control: Permits adjustment of sensing level of device.

2.17 OUTLETS
A. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
   1. Wattage Rating: 10 W unless otherwise indicated.
   2. Attenuation per Step: 3 dB, with positive off position.
   3. Insertion Loss: 0.4 dB maximum.
   4. Attenuation Bypass Relay: SPDT. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
   5. Label: "PA Volume."
B. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
C. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

2.18 BATTERY BACKUP POWER UNIT
A. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
B. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.
C. Battery shall be on float charge when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
D. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

2.19 CONDUCTORS AND CABLES
A. Jacketed, twisted pair and twisted multi-pair, untinned solid copper.
   1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.

3. Plenum Cable: Listed and labeled for plenum installation.

2.20 PATHWAYS

A. Conduit and Boxes: Comply with Section 27 05 28 "Pathways for Electronic Safety and Security Systems." Flexible metal conduit shall not be used.

B. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for pathways and boxes specified in Section 27 05 28 "Pathways for Electronic Safety and Security."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements in Section 27 05 28 "Pathways for Electronic Safety and Security." for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:
   1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
   2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
   3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
   5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

D. Equipment Cabinets and Racks:
   1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
   2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
   3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

E. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

F. Wall-Mounted Outlets: Flush mounted.

G. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

H. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

J. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

K. Connect wiring according to Section 27 15 13 "Communications Copper Horizontal Cabling" and Section 28 05 13 "Conductors and Cables for Electronic Safety and Security."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
C. Install grounding electrodes as specified in Section 27 05 26 "Grounding and Bonding for Communications Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Schedule tests with at least seven days' advance notice of test performance.
   2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
   3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
   4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
      a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
      b. Repeat test for each separately controlled zone of loudspeakers.
      c. Minimum acceptance ratio is 50 dB.
   5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
   6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
   7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
   8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Section 270526 "Grounding and Bonding for Communications Systems."

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Public address system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.
   1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.
3.7 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
   1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
   2. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING
A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

3.10 COMMISSIONING
A. See Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Electronic safety and security equipment coordination and installation.
      2. Common electronic safety and security installation requirements.
      3. Demolition.
      4. Cutting and patching for electrical construction.
      5. Touchup painting.
      6. Disposition of existing materials and equipment.
   B. Related Requirements:
      1. Section 078400 - Penetration Firestopping: For penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. Comply with NFPA 70.
   C. Comply with State and /or City Code requirements.
   D. All materials shall meet the standards of the following institutes where applicable:
      1. National Fire Protection Association (NFPA)
      2. American Society of Testing Materials (ASTM)
      3. American National Standards Institute (ANSI)
      4. National Electrical Manufacturer’s Association (NEMA)
      5. Institute of Electrical and Electronic Engineers (IEEE)

1.3 DISCONTINUED PRODUCTS
   A. The Engineer shall be notified as soon as possible of any discontinuance of production of any specified equipment and/or devices as discovered by the low voltage (Division 28) contractor; however, the low voltage (Division 28) contractor shall not be relieved from furnishing an Engineer approved alternate equipment and/or device of comparable design and quality without any extra cost to the Owner.

1.4 COORDINATION
   A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
      1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
      2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
      3. To allow right of way for piping and conduit installed at required slope.
      4. Connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
   B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 "Access Doors and Panels."

D. Coordinate chases, slots, inserts, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Core drilling through post-tensioned slab: The existing post-tensioned slabs contain post-tensioned tendons that must not be damaged or broken. No nailing, drilling, cutting or other disruption to the slab is allowed without prior written approval by the structural engineer. Contractor shall positively locate the existing tendons and submit to the structural engineer for approval a written procedure, including plans showing existing tendon locations and proposed disruption of the slab.

E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

F. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.5 DRAWINGS
A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. All devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.6 SITE INVESTIGATION
A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.

PART 2 PRODUCTS
2.1 NOT USED

PART 3 EXECUTION
3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION
A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 FIRESTOPPING

A. Firestopping: Provided by Section 078400 - Penetration Firestopping. Coordinate with Section 078400 for sealing of penetrations through fire and smoke barriers.

3.3 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Reroute safety and security cables as required to serve equipment not in the demolition area.

C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

D. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 7 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

E. Remove demolished material from Project site.

F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

H. Assume that existing equipment and fittings indicated to be reused are in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling.

I. Fittings and other equipment removed and to be-used shall be cleaned before reinstallation.

J. Added Cables: All cables added shall be coordinated with existing to remain. Where additional cables are added, identify cables per the system as exists in the facility.

K. All material and equipment which is noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the owner and stored where directed on the site.

L. Remove abandoned low voltage wiring. All wiring disconnected on one or both ends is considered abandoned unless tagged and labeled “future” or “spare”. Verify with Owner any cabling connected on both ends is still in use prior to removal.

3.4 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.
3.5 FIELD QUALITY CONTROL
A. Inspect installed components for damage and faulty work, including the following:
   1. Firestopping.
   2. Electrical demolition.
   3. Cutting and patching for electrical construction.
   4. Touchup painting.

3.6 REFINISHING AND TOUCHUP PAINTING
A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000 "Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION
A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.8 ELECTRONIC SAFETY AND SECURITY SERVICE OUTAGE AND ENERGIZATIONS
A. Owner Approval: Electronic safety and security service outages or energizations required shall be approved by the Owner before outages or energization. Outages shall be scheduled at the convenience of the Owner.
B. Written Request: Requests for outages and energizations shall be submitted in writing to the Owner for approval at the earliest possible date and in no case later than 14 days prior to the outage and/or energization.
C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours' notice has been given by the Owner.
D. Schedules: A minimum of two (2) weeks before the first outage, submit a schedule of proposed sequence of the electronic safety and security services outages and energizations. This schedule shall show construction energizations and shall include any weekend work. The schedule shall list the work to be completed during and between each outage.
E. Minimize outages on the Owner's electronic safety and security systems and employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary.
F. Before submitting any energization and/or outage requests, provide the owner with evidence that the following requirements have been met:
   1. Required equipment and material is on the job site. All related installations that can be worked on without an energization and/or outage are complete, tested, available for inspection, and ready for service.
   2. Shop drawings, test reports, installation data, and operational data have been submitted and approved.
   3. The energizing and outage schedule have been submitted and approved.
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. UTP cabling.
   2. Low-voltage control cabling.
   3. Control-circuit conductors.
   4. Fire alarm wire and cable.
   5. Identification products.

B. Related Requirements:
   1. Section 078400 - Penetration Firestopping: For penetration firestopping installed in fire-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. IDC: Insulation displacement connector.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

E. RCDD: Registered Communications Distribution Designer.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of electronic safety and security cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Installation data for UTP and optical-fiber cables as specified in TIA 568.1-D.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics, including the following:
      b. Patch panels.
      c. Patch cords.
   4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
   B. Source quality-control reports.
   C. Field quality-control reports.

1.6 QUALITY ASSURANCE
   A. Testing Agency Qualifications: An NRTL.
      1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Test cables upon receipt at Project site.
      1. Test each pair of UTP cable for open and short circuits.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1. Flame-Spread Index: 25 or less.
      2. Smoke-Developed Index: 50 or less.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 UTP CABLE
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. ADC.
      2. AMP NetConnect; a brand of Tyco Electronics Corporation.
      3. Belden Inc.
      4. Berk-Tek; a Nexans company.
      5. CommScope, Inc.
      6. Draka Cableteq USA.
      7. Genesis Cable Products; Honeywell International, Inc.
      8. Mohawk; a division of Belden Networking, Inc.
      9. Superior Essex Inc.
      10. SYSTIMAX Solutions; a CommScope, Inc. brand.
      11. 3M; Communication Markets Division.
   B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.
      1. Comply with ICEA S-90-661 for mechanical properties.
      4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
         a. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.
2.3 UTP CABLE HARDWARE
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ADC.
   3. AMP NetConnect; a brand of Tyco Electronics Corporation.
   4. Belden Inc.
   5. Dynacom Inc.
   6. Hubbell Incorporated; Hubbell Premise Wiring.
   7. Leviton Commercial Networks Division.
   8. Molex Premise Networks; a division of Molex, Inc.
   9. Panduit Corp.
  10. Siemon.
B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

2.4 CONTROL-VOLTAGE CABLE
A. Paired Cable: NFPA 70, Type CMG.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1581.
B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

2.5 CONTROL-CIRCUIT CONDUCTORS
A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
B. Class 2 Control Circuits: Stranded copper, power-limited cable, complying with UL 83, concealed in building finishes.

2.6 FIRE ALARM WIRE AND CABLE
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Draka Cableteq USA.
   3. Genesis Cable Products; Honeywell International, Inc.
   4. Pentair
   5. Rockbestos-Suprenant Cable Corp.
   6. West Penn Wire.
B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
C. Signaling Line Circuits: Twisted, shielded pair, not less than size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.
   3. Multi-conductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

E. Electrical Circuit Integrity Cable (CI): Unshielded and sized as recommended by system manufacturer.
   1. Electrical Circuit Integrity Cable (CI): Twisted unshielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 FHIT System No. 28A for a 2-hour survivability rating.
      a. Cable shall be Radix model # CI1640102-0000-15000, 16AWG solid conductor and/or CI14A0702-0000-15000, 14AWG stranded.
      b. UL Listed Cable shall be installed as an assembly routed in EMT conduit w/minimum size of 3/4” throughout as specified in UL 2196 FHIT System No. 28A.
      c. All raceway couplings and supports shall be UL Listed as an assembly per UL 2196 FHIT System No. 28A.
      d. Contractor to consult most current UL 1424 and UL 2196 FHIT System No. 28A publication (and any other referenced or relating) for a 2-hour survivability assembly prior to installation and shall consult electrical professional engineer (PE) of record for approved equals.

2.7 IDENTIFICATION PRODUCTS
   A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1. Brady Worldwide, Inc.
      3. Kroy LLC.
      4. Panduit Corp.
   B. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
   C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS
   A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD
   A. Install wiring in metal pathways and wireways.
      1. Minimum conduit size shall be 3/4 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
      2. Comply with requirements in Division 28 Section "Pathways for Electronic Safety and Security."
      3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
   B. Install cable, concealed in accessible ceilings, walls, and floors when possible.
   C. Wiring within Enclosures:
      1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
4. Install conductors parallel with or at right angles to sides and back of enclosure.
5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
6. Mark each terminal according to system’s wiring diagrams.
7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 INSTALLATION OF CONDUCTORS AND CABLES
A. Comply with NECA 1.
B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
C. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
D. Install UTP, optical-fiber, and coaxial cables and connecting materials after spaces are complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
E. General Requirements for Cabling:
   1. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels. Leave a minimum of 6 inches (150 mm) of slack at outlet terminations and coil loosely into box after termination on outlet fitting.
   2. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   3. Maintain minimum cable bending radius during installation and termination of cables.
   4. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   5. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
F. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart. Cable supports shall be fastened to structural members or floor slabs in accordance with Section 260529 "Hangers and Supports for Electrical Systems."
   3. Cable shall not be run in contact with pipes, ducts, or other potentially damaging items. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
G. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Coil cable 72 inches (1830 mm) long shall be neatly coiled not less than 12 inches (300 mm) in diameter below each feed point.
H. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
   1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
   2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Type MI permitted. CI cables must be installed in a 2-hour fire-rated shaft or encased in concrete with a 2-hour fire rating.
   3. 2-Hour Fire Rated Assemblies: All components of 2-hour rated assembly systems must have the same UL FHIT listing. Submit FHIT listing documentation with shop drawing submittal.
   4. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS
A. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits, No. 14 AWG.
   2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.6 CONNECTIONS
A. Comply with requirements in Section 281600 "Intrusion Detection" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Section 281300 "Access Control" for connecting, terminating, and identifying wires and cables.

C. Comply with requirements in Section 282350 "IP (Network) Video Surveillance System" for connecting, terminating, and identifying wires and cables.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING
A. Comply with requirements in Section 078413 "Firestopping."

3.8 GROUNDING
A. For communications wiring, comply with J-STD-607-B and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 280526 "Grounding and Bonding for Electronic Safety and Security."

3.9 IDENTIFICATION
A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568.1-D.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
1. Metal conduits, tubing, and fittings.
2. Metal wireways and auxiliary gutters.
3. Nonmetallic wireways and auxiliary gutters.
4. Surface pathways.
5. Boxes, enclosures, and cabinets.
B. Related Requirements:
1. Section 078400 - Penetration Firestopping: For penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 DEFINITIONS
A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.3 SUBMITTALS
A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
C. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of pathway groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
D. Qualification Data: For professional engineer.
E. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   3. Anamet Electrical, Inc.
   4. Bridgeport Fittings, Inc.
   5. Electri-Flex Company.
   7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
   8. Republic Conduit.
   9. Robroy Industries
   10. Southwire Company.
12. Western Tube and Conduit Corporation.

B. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.
D. ARC: Comply with ANSI C80.5 and UL 6A.
E. IMC: Comply with ANSI C80.6 and UL 1242.
F. EMT: Comply with ANSI C80.3 and UL 797.
G. FMC: Comply with UL 1; zinc-coated steel.
H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Fittings for EMT:
   a. Material: Steel or Zinc die cast.
   b. Type: Setscrew or compression.
2. EMT Fittings Materials:
   a. All Zinc materials shall be ASTM B86 certified
   b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
   c. All Steel shall be SAE 1050.
3. EMT Fittings Design:
   a. Zinc die cast components shall be ball burnished.
   b. Steel parts shall be zinc plated for corrosion protection.
   c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
   d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
   e. All fitting throat diameters shall be smooth with no sharp edges or slag.
   f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
   g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.
4. Transition Fittings:
   a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one raceway type to another must be UL listed for that application.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.
C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Mono-Systems, Inc.
      b. Niedax-Kleinhuys USA, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hubbell Incorporated; Wiring Device-Kellems Division.
      b. Lamson & Sessions; Carlon Electrical Products.
      c. Mono-Systems, Inc.
      d. Panduit Corp.
      e. Wiremold / Legrand.

D. Tele-Power Poles:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Mono-Systems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.
   3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   5. Hoffman; a Pentair company.
   6. Hubbell Incorporated; Killark Division.
   7. Lamson & Sessions; Carlon Electrical Products.
   8. Milbank Manufacturing Co.
   9. Molex, Woodhead Brand
   10. Mono-Systems, Inc.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with TIA-569-B.
   2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Device Box Dimensions: 4-inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

J. Gangable boxes are prohibited.

PART 3 EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC or IMC.
   2. Concealed Conduit, Aboveground: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: GRC or IMC.
   6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).
D. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression, steel or Zinc die-cast metal fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20 and UL514B.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Raceways Within 1 ½” of Roof Deck:
   1. All raceway shall be installed further from 1 ½” of roof deck or raceway shall be RMC or IMC.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

R. Surface Pathways:
   1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
   3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

T. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building or structure.
   3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain-tight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

DD. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

EE. Set outlet boxes for flush mounted devices to within 1/8" of finished wall.
FF. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8” of finished wall.

GG. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

HH. Firestopping: Provided by Section 078400 - Penetration Firestopping. Coordinate with Section 078400 for sealing of penetrations through fire and smoke barriers.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section “Firestopping.”

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION
PART 1 GENERAL

1.1 APPLICABLE DOCUMENTS

A. The Drawings, the provisions of the Contract, including General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

B. All Division 26 Sections.

1.2 SUMMARY

A. Section includes:
   1. Provisions for access control components including conduit, boxes, and power.
   2. Access control system work performed by the Hennepin County Security System Contractor:
      a. Access control devices installation.
      b. Access control cabling.
      c. Access Control Panels.
      d. Access Control Power Supplies.
      e. System programming.
      f. Software licenses and workstation configuration.
      g. Smart Relay and Smart Relay programming for integration of power door operators.
      h. Network coordination and connection to the Hennepin County Security Wide Area Network.
      i. Coordination with the Security Contractor.
      j. Integration of Video Surveillance and Intercom Systems.
      k. Contact Information for the Hennepin County Security Integrator: VTI Security - Minnesota
         401 West Travelers Trail
         Burnsville, Minnesota 55337
         Voice: 952.894.5343 Fax: 952.894.0509
         Email: vti@vtisecurity.com

PART 2 PRODUCTS

2.1 PRODUCTS

A. Provide products as specified in Section 280528 “Pathways for Electronic Safety and Security.”

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Coordinate with the Hennepin County Security Contractor

B. Card Reader Doors
   1. Provide two-gang box with flush single gang extension ring at doors shown. Provide ¾-inch EMT with pullstring from box, concealed in wall, to accessible ceiling space.

C. Power Door Operators
   1. Provide ¾-inch EMT with pullstring from door transfer device, concealed in wall, to accessible ceiling space.

3.2 COMMISSIONING

A. See Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE DOCUMENTS

A. The Drawings, the provisions of the Contract, including General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

B. All Division 26 Sections.

1.2 SUMMARY

A. Section includes:
   1. Provisions for video surveillance control components including conduit, boxes, and power.
   2. Video surveillance system work performed by the Hennepin County Security System Contractor.
      a. Video surveillance devices installation.
      b. Video surveillance cabling.
      c. Video surveillance panels.
      d. Video surveillance power supplies.

B. System shall include IP cameras as described in this section and on the drawings.
   1. Local server/storage needs are TBD.

C. The Category 6 cabling to each camera shall be provided by the structured cabling Contractor. Patch cords for the IP cameras to the network switches shall be furnished by this Contractor and installed by the Owner with participation by this Contractor. Patch cords from the IP Camera to the data jack shall be furnished by this Contractor and installed by this Contractor.

D. General Contractor shall provide, pre-test, and install IP cameras per specifications and in the locations indicated on the drawings.

E. Programming and configuration of IP Cameras and Video Surveillance System shall be provided by the approved Hennepin County Video Surveillance Integrator, subcontracted by the General Contractor.
   1. Contact information for the Hennepin County Video Surveillance Integrator:
      a. Egan Company
         Attention: Kurt Johnson, Account Manager
         11611 Business Park Boulevard North
         Champlin, MN 55316
         Direct: 763.732.7404 Cell: 612.328.2962
         Email: kdj@eganco.com

1.3 REFERENCES

A. Section 28 05 00 – Common Work Results for Electronic Safety and Security

B. Section 28 13 00 – Card Access System

C. This section (28 23 00) is subject to all of the applicable provisions of the above indicated sections.

D. Reference Standards: Systems specified in this Section shall meet or exceed the requirements of the following:
   1. Federal Communications Commission (FCC):
      b. FCC Part 68 – Connection of Terminal Equipment to the Telephone Network
2. Underwriters Laboratories (UL):
   a. UL294 – Access Control System Units
   b. UL1076 – Proprietary Burglar Alarm Units and Systems
4. Electronic Industries Alliance (EIA):
   a. RS232C – Interface between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange
   b. RS485 – Electrical Characteristics of Generators and Receivers for use in Balanced Digital Multi-Point Systems
5. Federal Information Processing Standards (FIPS):
   a. Advanced Encryption Standard (AES) (FIPS 197)
   b. FIPS 201: Personal Identity Verification (PIV) of Federal Employees and Contractors

1.4 SYSTEM DESCRIPTION

A. The work consists of providing and installing prescribed systems and equipment, in accordance with the Owner’s directives and needs. The Contractor shall install, and configure systems to provide the exact function described herein and will be held to the operational criteria. Contractor shall be responsible for providing and installing a complete and fully operational system, with the intended features and capabilities, whether or not all required parts, components, systems or accessories are specified in the construction documents. Contractor shall provide all required parts, components, systems, materials and accessories needed for a complete and working system, without additional cost to the owner.

B. System shall provide a complete and operational closed-circuit television surveillance security for selected interior and exterior areas of building as shown on Drawings.

C. All existing cameras and their associated cabling shall be removed. The cameras shall be turned over to the Owner.

D. All new cameras shall be IP based. Coordinate with Owner for final connection from patch panel to network switch, IP addressing requirements.

E. Provide all new cameras with licensing as required for integrating camera’s to the Owners Network Video Recorder (Network Video Recording will be provided by Owner under separate contract).

F. Different types of camera assemblies are used on the Project. Refer to Drawings for camera types and locations. Each camera shall be provided as a manufacturer’s assembly designed by the manufacturer to be an integral package. Each camera shall include day/night technology. Provide following camera types at locations shown on Electronic Safety and Security Plan and Detail sheets:
   1. Type A: Fixed 105° Semi Recessed Ceiling or Wall Mounted Single-View Indoor Cameras
   2. Type B: Fixed 180° Semi Recessed Ceiling or Wall Mounted Multi-View Indoor Cameras
   3. Type C: Fixed 180° Semi Recessed Ceiling or Wall Mounted Multi-View Outdoor Cameras
   4. Type D: Fixed 360° Semi Recessed Ceiling or Wall Mounted Multi-View Outdoor Cameras

G. Video surveillance cameras shall be an interior fixed megapixel day/night camera in a tamper resistant dome enclosure which shall protect the cameras from dust, dirt, and physical damage in a complete integrated package. Video surveillance cameras shall be either ceiling mounted or wall mounted.
   1. Ceiling mounted cameras shall be semi recessed ceiling mounted. The cameras shall include ceiling mount hardware. Provide 10 feet of spare cable at each ceiling mounted camera for future adjustments in the camera position that may be required.
   2. Wall mounted cameras shall be wall mounted. The cameras shall include wall mount hardware.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Reviewed and stamped by RCDD.
   1. Title sheet showing the Project Name, Project Location, Specification Title and Specification number, contractor's name, address, phone number, RCDD Registration Stamp with signature and date submitted. Clear area shall be provided on the title sheet for shop drawing review stamps.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Provide certificates of training for Voice and Data premise cabling, per ANSI/TIA/EIA 568, for supervisors of installation personnel. Certificates shall be acceptable from a manufacturer of the equipment listed or an independent training company.
   7. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   8. Confirmation that products are registered components for the manufacturer's warranty.
  10. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
  11. Cabling administration Drawings and printouts.
  12. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
      b. Electronic Safety and Security CCTV Camera locations.

C. Twisted pair cable testing plan.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
B. Product Certificates: For each type of product.
C. Source quality-control reports.
D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS
A. Maintenance Data: For Cameras and Mounting Hardware maintenance manuals.
B. As-Built/Record Drawings:
   1. Two sets in hard copy format and two sets in electronic Auto CAD format, including bid submittals, revised shop drawing and product data showing:
      a. Final configuration of the system
      b. Floor plans showing cable routes and camera locations with camera ID's.
   2. Hard copy information shall be in type written or printed form in a useful format.

1.8 QUALITY ASSURANCE
A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing Agency must have personnel certified by BICSI on staff.
   1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 PROJECT CONDITIONS
   A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION
   A. Coordinate layout and installation of cameras and cabling with Owner’s telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Axis Communications or pre-approved equal.
   B. Provide all equipment required for a complete installation, such as mounting hardware, connectors, low voltage power supplies, cable, and other electrical components.

2.2 SYSTEM SERVER AND SOFTWARE (EXISTING)
   A. Server will be provided by Owner under separate contract.

2.3 CCTV SURVEILLANCE CAMERAS
   A. Provide interior fixed Video Surveillance Cameras with the following minimum specifications:
      1. Type A - 180° Fixed Camera Assemblies:
         a. Manufacturer: Axis Communications or Approved Equal
         b. Model Number: P3717-PVE
         c. CCTV surveillance camera mounting hardware
      2. Type B - 180° Fixed Camera Assemblies:
         a. Manufacturer: Axis Communications or Approved Equal
         b. Model Number: Q3709-PVE
         c. CCTV surveillance camera mounting hardware
      3. Type C - 105° Fixed Camera Assemblies:
         a. Manufacturer: Axis Communications or Approved Equal
         b. Model Number: Q3515-LV
         c. CCTV surveillance camera mounting hardware
      4. Type D - 360° Fixed Camera Assemblies:
         a. Manufacturer: Axis Communications or Approved Equal
         b. Model Number: Q6000-E MK II
         c. CCTV surveillance camera mounting hardware

2.4 PATCH CABLES
   A. Install patch cables and camera cables with the following minimum specifications:
2.5 POWER SUPPLIES
   A. Provide 24VAC power supplies as required or as shown on the drawings.
   B. Manufacturer: Altronix 1024ULACM or approved equal.
   C. Provide each power supply with standby batteries.

PART 3 - EXECUTION

3.1 WIRING METHODS
   A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
      1. Install plenum cable in environmental air spaces, including plenum ceilings.
      2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
   B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
   C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS
   A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
   B. Comply with Section 270528 "Pathways for Electronic Safety and Security Systems."
   C. Drawings indicate general arrangement of pathways and fittings.

3.3 FIRESTOPPING
   A. Comply with requirements in Section 078413 "Penetration Firestopping."
   B. Comply with TIA-569-D, Annex A, "Firestopping."
   D. Provide conduit sleeves through penetrations of fire rated walls and floor/ceiling penetrations.

3.4 IDENTIFICATION
   A. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.
   B. CCTV Surveillance Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for terminal hardware and positions, horizontal cables and camera's
   C. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements.
3.5 FIELD QUALITY CONTROL
   A. Perform tests and inspections with the assistance of a factory-authorized service representative.
   B. Tests and Inspections:
      2. Visually inspect CCTV camera equipment and patch cords, and labeling of all components.

3.6 COMMISSIONING
   A. See Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Fire Alarm Control Panel. (Existing)
   3. System smoke detectors.
   6. Device guards.
   7. Magnetic door holders.
   9. Graphic annunciator.
  10. Addressable interface device.
  11. Network communications.
B. System Spare Capacity
   1. Provide spare capacity for fire alarm circuits as required below.
      b. Amplifier Circuits: 25% spare capacity for each circuit installed.
      c. Signaling Line Circuits (SLC): 25% spare capacity for each circuit installed.
C. Related Requirements:
   1. Section 087100 “Door Hardware”
   2. Section 280500 “Common Work Results for Electronic Safety and Security”
   3. Section 230900 “Instrumentation and Controls for HVAC”
   4. Section 230993 “Sequence of Operation for HVAC Controls”

1.2 DEFINITIONS
A. EMT: Electrical Metallic Tubing.
B. FACP: Fire Alarm Control Panel.
C. HLI: High Level Interface.
E. PC: Personal computer.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.
B. Shop Drawings: For fire-alarm system.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
7. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
8. Include plans, elevations, sections, details, and attachments to other work.
9. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
10. Detail assembly and support requirements.
11. Include voltage drop calculations for notification-appliance circuits.
12. Include battery-size calculations.
13. Include input/output matrix.
14. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
15. Include performance parameters and installation details for each detector.
16. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
17. Include performance parameters and installation details for each surge suppression module.
18. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
19. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
20. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified, fire-alarm technician; Level III minimum, Level IV preferred.
   c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017800 "Closeout Submittals," include the following and deliver copies to authorities having jurisdiction:
   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide “Fire Alarm and Emergency Communications System Record of Completion Documents” according to the “Completion Documents” Article in the “Documentation” section of the “Fundamentals” chapter in NFPA 72.

c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.

d. Riser diagram.

e. Device addresses.

f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.

g. Record copy of site-specific software.

h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
   1) Equipment tested.
   2) Frequency of testing of installed components.
   3) Frequency of inspection of installed components.
   4) Requirements and recommendations related to results of maintenance.
   5) Manufacturer's user training manuals.

i. Manufacturer's required maintenance related to system warranty requirements.

j. Abbreviated operating instructions for mounting at Fire Alarm Control Panel and each annunciator unit.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   3. Smoke Detectors and Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
   4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
   5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
   6. Audible and Visual Notification Appliances: One of each type installed.
   7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
   8. Surge Protection devices: 2 of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
1.8 PROJECT CONDITIONS
A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 SEQUENCING AND SCHEDULING
A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.10 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

PART 2 PRODUCTS
2.1 SYSTEM DESCRIPTION
A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/ or horn/strobe evacuation.
C. Automatic sensitivity control of certain smoke detectors.
D. All components provided shall be listed for use with the selected system.
E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 EXISTING FIRE-ALARM SYSTEM
A. Compatibility with Existing Equipment: Fire-alarm system and components shall operate as an extension of an existing system.
2.3 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire Alarm Systems Operation Matrix

<table>
<thead>
<tr>
<th>Initiating Device</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot type smoke detector</td>
<td>X1</td>
<td>X1</td>
<td>X1</td>
<td>X</td>
<td>--</td>
<td>--</td>
<td>X</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Spot type heat detector</td>
<td>X1</td>
<td>X1</td>
<td>X1</td>
<td>X</td>
<td>--</td>
<td>--</td>
<td>X</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Duct Smoke Detector – Damper</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td>--</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>--</td>
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<td>--</td>
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<tr>
<td>Pre-action heat detector alarm output</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Class “A” Network wire fault</td>
<td>X3</td>
<td>X3</td>
<td>X3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Communication Network Fault</td>
<td>X3</td>
<td>X3</td>
<td>X3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Communication Fault Digital Communicator</td>
<td>X3</td>
<td>X3</td>
<td>X3</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
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<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Fire Alarm Battery or Charger Failure</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>User disabling of zones or individual devices</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Open circuits, shorts, and grounds in designated circuits.</td>
<td>X3</td>
<td>X3</td>
<td>X3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Loss of communication with any addressable device</td>
<td>X3</td>
<td>X3</td>
<td>X3</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Ground or a single break in internal circuits of fire-alarm control panel</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Abnormal ac voltage at fire-alarm control panel</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Break in standby battery circuitry</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Abnormal position of any switch at fire-alarm control panel or annunciator</td>
<td>X3</td>
<td>X3</td>
<td>X3</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Common alarm Signal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Common supervisory signal</td>
<td>X</td>
<td>X</td>
<td>*</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Common trouble signal</td>
<td>X</td>
<td>X</td>
<td>*</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>X</td>
</tr>
</tbody>
</table>

TYPE of SIGNAL
X1 = Alarm Signal
X2 = Common supervisory signal
X3 = Common trouble signal.
-- = Action not required.

SYSTEM OPERATION
A = Annunciate specific device at FACP and remote annunciators FAAP.
B = Annunciate specific device at graphic video terminals on Fire Alarm Network
C = Transmit to Central Station/Monitoring.
D = Activate notification appliances as described in specification.
E = Activate relay to close damper.
F = Activate relay to shutdown AHU fan, unless specifically noted otherwise.
G = Activate Exterior Bell/Horn/Strobe.
I = Release all the hold open smoke doors indicated on the drawings.
J = Recall elevator in designated bank.
K = Transmit status to elevator controller
M = Transmit status to access control panel, refer to 281300 for access control system protocol
N = Record events in system memory

MATRIX GENERAL NOTES:

* After a time delay of 200 seconds, transmit trouble or supervisory signal to the remote alarm receiving station.
** Where a paging system is provided shall cease/mute operation during notification appliance activation and reset to normal when the fire alarm system is reset to normal.
2.4 FIRE ALARM CONTROL PANEL (EXISTING)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. EST; a UTC company.
   3. Faraday.
   4. Fike Corporation.
   5. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
   6. Gamewell-FCI by Honeywell
   7. GE UTC Fire & Security
   8. Harrington Signal, Inc.
  10. Mircom Technologies, Ltd.
  11. Notifier. Inc, a Honeywell company
  13. Silent Knight.
  14. SimplexGrinnell LP.

B. General Requirements for Fire Alarm Control Panel:
   1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
      a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
      b. Include a real-time clock for time annotation of events on the event recorder and printer.
      c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
      d. The FACP shall be listed for connection to a central-station signaling system service.
      e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
   2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
   3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at Fire Alarm Control Panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
   1. Pathway Class Designations: NFPA 72, Class B.
   2. Install no more than 256 addressable devices on each signaling-line circuit.
   3. Serial Interfaces:
      a. One dedicated RS 485 port for central-station operation using point ID DACT.
      b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
      c. One USB port for PC configuration.
E. Smoke-Alarm Verification:
   1. Initiate audible and visible indication of an "alarm-verification" signal at Fire Alarm Control Panel.
   2. Activate an approved "alarm-verification" sequence at Fire Alarm Control Panel and detector.
   3. Record events by the system printer.
   4. Sound general alarm if the alarm is verified.
   5. Cancel Fire Alarm Control Panel indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:
   1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
   2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
   3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provide as a special module that is part of Fire Alarm Control Panel.
   1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
      a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
      b. Programmable tone and message sequence selection.
      c. Standard digitally recorded messages for "Evacuation" and "All Clear."
      d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of Fire Alarm Control Panel.
   2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
   3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
   1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
2.5 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. EST; a UTC company.
   2. Faraday.
   3. Fike Corporation.
   4. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
   5. Harrington Signal, Inc.
   7. Mircom Technologies, Ltd.
   8. Notifier, Inc., a Honeywell company
  10. Silent Knight.
  11. SimplexGrinnell LP.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to Fire Alarm Control Panel.
   2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. EST; a UTC company.
   2. FAST
   3. Faraday.
   4. Fike Corporation.
   5. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
   6. GE UTC Fire & Security; A United Technologies Company.
   7. Harrington Signal, Inc.
   9. Mircom Technologies, Ltd.
  10. Notifier, Inc., a Honeywell company
  12. Silent Knight.
  13. SimplexGrinnell LP.
  15. Xtralis Pty Ltd.

B. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Detectors shall be two-wire type.
   3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to Fire Alarm Control Panel.
   4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
   a. Multiple levels of detection sensitivity for each sensor.
   b. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from Fire Alarm Control Panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at Fire Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

D. Ionization Smoke Detector:
1. Detector address shall be accessible from Fire Alarm Control Panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at Fire Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from Fire Alarm Control Panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at Fire Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.7 HEAT DETECTORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. EST; a UTC company.
2. Faraday.
3. Fike Corporation.
4. Fire Control Instruments, Inc.: Gamewell; a Honeywell company.
5. GE UTC Fire & Security; A United Technologies Company.
6. Harrington Signal, Inc.
8. Mircom Technologies, Ltd.
11. Silent Knight.
12. SimplexGrinnell LP.

B. General Requirements for Heat Detectors: Comply with UL 521.
   1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C)
   or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or
      trouble) to Fire Alarm Control Panel.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed
   temperature of 190 deg F (88 deg C).
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or
      trouble) to Fire Alarm Control Panel.

2.8 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering
   products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Wheelock.
   2. EST; a division of GE Security.
   4. Fire Control Instruments, Inc.; a Honeywell company.
   5. GAMEWELL.
   6. GE UTC Fire & Security; A United Technologies Company.
   8. Harrington Signal, Inc.
   10. Mircom Technologies, Ltd.
   13. SimplexGrinnell LP.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal
   circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for
   system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting
      assembly, equipped for mounting as indicated, and with screw terminals for system
      connections.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating
   mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of
   90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464
   test protocol.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal
   white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in
   minimum 1-inch-(25-mm-) high letters on the lens.
   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.

E. Voice/Tone Notification Appliances:
1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1/8 to 2 W.
5. Frequency Range: 300Hz to 8000Hz
7. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.9 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES
A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.10 MAGNETIC DOOR HOLDERS
A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: 24-V ac or dc.
   4. Rating: 120-V ac.
B. Material and Finish: Match door hardware.
C. Provide a local switch for hold open release.

2.11 SECONDARY POWER SUPPLIES
A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. EST; a UTC company.
   2. Honeywell Power Supplies
   3. Altronix Power Supplies
B. Standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for 24-hours and capable of operating the system for fifteen 15-minutes of evacuation alarm on all devices, operating at maximum load.
C. The system shall include a charging circuit to automatically maintain the electrical charge of the battery and supervise the integrity of the battery. The system shall automatically adjust the charging rate of the battery to compensate for temperature.
D. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.
E. Secondary power supplies shall also meet the minimum specifications:
   1. The power supply shall meet or exceed the following specifications:
      a. The design shall consist of grey or red steel wall-mount housing with a locking door.
      b. The power supply shall provide with isolated 24 VAC outputs.
      c. The power supply shall provide resettable fuses for each output.
      d. PTC protected outputs shall meet Class 2, power limited, requirements.
      e. Notification Appliance Circuit (NAC) power extenders shall have the capability to synchronize all strobe and audible signals in accordance with NFPA-72.
      f. All power supplies shall be electrically supervised and report a trouble signal for all fault and failure conditions.
   2. The electrical specifications for the power supply shall be as follows:
      a. Input voltage: 120 VAC
      b. Input power: 400 VA
      c. Output voltage: 24 VAC
      d. Output power: 50 VA

2.12 ADDRESSABLE INTERFACE DEVICE

A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall or to circuit-breaker shunt trip for power shutdown.
   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. AHU shutdown relays shall be provided where air handler shutdown is required. The shutdown relay shall be controlled by either a supervised NAC circuit, independently controlled programmable supervised duct detector output circuit, or I/O point circuit. The shutdown relay shall not be controlled by an electronic control module. Each shutdown relay shall have two sets of form C contacts, the first set to be used for the shutdown signal and the second set used for notification to the building automation system.

E. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.

2.13 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer’s written requirements.

B. Provide network communications pathway per manufacturer’s written requirements and requirements in NFPA 72 and NFPA 70.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer’s written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before all other trades have completed cleanup shall be replaced.
   2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
   1. Connect new equipment to existing control panel in existing part of the building.
   2. Connect new equipment to existing monitoring equipment at the supervising station.
   3. Expand, modify, and supplement existing control equipment as necessary to extend existing [control] [monitoring] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

D. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
   4. Install alarm cover where noted.

E. Smoke- or Heat-Detector Spacing:
   1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
   2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
   3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
   5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
   1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

J. Audible Alarm-Indicating Devices: Install wall mounted devices not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

K. Ceiling Mounted Audible/Visual and Visual Only Alarm-Indicating Devices: Install flush on ceiling in approximate location indicated. Coordinate with all ceiling mounted diffusers, lights, devices, etc. Provide concealed mounting where noted with UL listed device.

L. Visible Alarm-Indicating Devices: Install wall mounted devices adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

N. Provide microelectronic monitor modules with 120V relays for each smoke damper connection to provide individual programmed control of damper(s).

O. Provide microelectronic monitor modules for AHU for power shutdown. The shutdown relay shall be located adjacent to the controller for the AHU.

3.3 PATHWAYS

A. Conductors and cables above recessed ceilings and in non-accessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Conductors and cables shall be installed in EMT.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for structured cabling is 1 inch (27 mm).

D. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated HVAC duct systems.
   2. Magnetically held-open doors.
   3. Electronically locked doors and access gates.
   4. Data communication circuits for connection to building management system.
   5. Data communication circuits for connection to mass notification system.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
3.6 GROUNDING
A. Ground Fire Alarm Control Panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to Fire Alarm Control Panel.
B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL
A. Field tests shall be witnessed by authorities having jurisdiction.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visual Inspection: Conduct visual inspection prior to testing.
   2. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
      a. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
   4. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
   5. Test audible appliances for the private operating mode according to manufacturer's written instructions.
   6. Test visible appliances for the public operating mode according to manufacturer's written instructions.
   7. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.
G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE
A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.
B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [two] <Insert number> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

3.11 COMMISSIONING

A. See Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION
1.1 SCOPE
A. Refer to Section 28 05 00 for additional project scope information.
B. This section describes the requirements, criteria, and scope of work to install Intrusion Detection System.
C. The Contractor shall provide and install a fully functional Intrusion Detection System (IDS) with software and hardware functionality as described herein.
D. The Scope-of-Work shall include, but not be limited to the following:
   1. Provide necessary materials, hardware, software and cabling required to furnish a fully functional system as described by this specification document and depicted on accompanying project drawings.
   2. Provide low voltage signal, control, and power cables to and from power supplies, remote panels, expansion panels, and other devices as required for a complete turnkey installation explicitly indicated on drawings and fully described by this document.
   3. Coordinate with Electrical Contractor (EC) for provision of conduits and high voltage power where necessary.
   4. Install all System devices, materials, and equipment, and program and/or adjust as indicated by the equipment manufacturers’ published literature, unless specifically noted herein to the contrary by this document.
   5. The Hennepin County Intrusion Detection System Integrator shall be responsible for any and all related programming.
   6. Contact information for the Hennepin County Intrusion Detection System Integrator, subcontracted by the General Contractor:
      a. Egan Company  
         Attention: Kurt Johnson, Account Manager  
         11611 Business Park Boulevard North  
         Champlin, MN 55316  
         Direct: 763.732.7404 Cell: 612.328.2962  
         Email: kdj@eganco.com
    7. Furnish the following, as needed, to provide a complete and fully functional system:
       a. Control Panel(s)  
       b. Expansion Panel(s)  
       c. Wall mounted Key pads  
       d. Signal Devices  
       e. Motion Detectors  
       f. Door contacts  
       g. Wire and Cable  
       h. Audible Alarm/Sirens audio alert devices  
       i. Cabinets and enclosures  
       j. UPS and Batteries  
       k. Hangers, supports and cable management devices  
       l. Other necessary equipment to meet the installation need as implied

1.2 RELATED DOCUMENTS
A. Section 013100 – Project Management and Coordination
DEFINITIONS
A. Refer to Section 28 05 00 for additional definitions.

REFERENCE STANDARDS AND CODES
A. Refer to Section 28 05 00 for additional requirements.

QUALIFICATIONS
A. Refer to Section 28 05 00 for additional requirements.

PRE-CONSTRUCTION SUBMITTALS
A. The Contractor shall submit the intrusion detection hardware layouts which includes the number of controllers, sub-panels and other associated devices per location.
B. The Contractor shall submit Intrusion Detection equipment shop drawings and/or data sheets for review by Hennepin County Security System Engineer for final review.
C. The Contractor shall submit full power calculations which includes the anticipated power loads, number and type of power supplies including all power supply boards, number of 120VAC circuits required, battery backup including the quantities of batteries to meet requirements, PoE loads, fire alarm connection requirements, etc.
D. Refer to Section 28 05 00 for additional requirements.

GENERAL SUMMARY
A. This section includes products and execution requirements relating to furnishing and installing a complete and functional Intrusion Alarm system as described in this specification, and indicated on project drawings.
B. Contractor shall provide low voltage power and control lines to and from power supplies, remotely controlled equipment, and other devices, even though not explicitly indicated on drawings or listed in equipment tables.
C. Contractor shall be responsible for the coordination and provision of high voltage power and conduits where necessary.
D. Contractor is responsible for providing own cable and sleeve penetrations, coring, and other infrastructure work unless specifically noted otherwise.
E. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.
F. The system shall include all hardware and software, control panels, interfaces, communication devices, cable/wire, raceways, enclosures, mounting hardware, and all other equipment as required for a turnkey Intrusion Alarm system.
G. A general description, as well as detailed functional and technical drawings, for the complete intrusion alarm system at all site locations. This also includes all manuals, documentation, and operational information necessary for the maintenance, training, and operation of the intrusion alarm system.
H. The Hennepin County Intrusion Detection System Integrator shall be responsible for any and all related programming.
I. The system shall include, but not be limited to:
   1. Alarm Control panels
   2. Motion detectors
   3. Acoustic glass break detectors
   4. Door contacts
5. Control keypads
6. Multi zone expansion panels as required

J. System Functions:
   1. The intent of the system is to detect intrusion and motion events within the building and to notify
      the Owner’s monitoring company of such events.
   2. The system shall provide both silent and audible intrusion alerts that can be used together or
      separately.
   3. The system shall be zoned (programmed) with logical (Owner defined) multiple access zones or
      sections while not deactivating the total system.
   4. Door contacts shall be individual zones, except for multiple sensors or detectors motion the
      same door set or window/glass set.

K. IDS shall include and meet the following requirements:
   1. Type Class B
   2. Multi-zone
   3. Annunciated
   4. Combination manual and automatic
   5. Supervised circuitry
   6. Single stage
   7. Local Protective Signaling
   8. Remote telephone monitoring interface
   9. Sequence of operation by devices activation
   10. Alarm system activation
   11. Enunciator activation
   12. Control lock-in
   13. Automatic dialer contacts monitoring company with required information
   14. Activation acknowledged operation
   15. Visual signals remain activated
   16. Subsequent device activation
   17. Alarm system resounds

1.8 SYSTEM ARCHITECTURE
A. The intrusion alarm system shall provide zoned detection and primary and secondary notification of
   unwanted and forced entries into a facility. Security devices such as door contacts and motion
   detectors will be installed at specified areas and provide on and off-site detection, and in-turn
   notification of these unwanted events. The Owner will provide the 24-hour alarm monitoring
   company information to the Contractor for programming.

B. The intrusion alarm system shall provide motion detection and door contact coverage of all egress
   and ingress doors and roof hatches of the facility.

C. The intrusion alarm system shall be compatible with the County’s existing intrusion alarm panels
   and devices, and monitoring systems/services.

D. Network
   1. The intrusion alarm system hardware shall be capable of interfacing to an IEEE 802.3 standard
      local area network (LAN).

PART 2 - PRODUCTS

2.1 ALARM CONTROL PANEL
A. Manufacturer:
   1. Shall be Bosch Security, model number B9512G.

2.2 KEYPADS
A. The keypads shall interface directly with the intrusion control panel.
B. The keypad shall be a backlit LCD touch screen.
C. The keypad LCD screen shall display zone status and enable control for setting the system.
D. Manufacturer:

2.3 DOOR CONTACTS/DOOR POSITION SWITCHES
A. Sealed and potted magnetic reed switch in contact housing.
B. Provide DPDT for applications with multiple security systems are utilizing a single door contact.
C. Provide color that matches door as close as possible.
D. Provide recessed switch whenever possible.
E. Provide for recessed applications.
   1. Shall match County standards.
F. Provide for surface mount applications.
   1. Shall match County standards.
G. Provide for overhead door applications.
   1. Shall match County standards.

2.4 MOTION DETECTORS
A. The motion detector shall be a multi-technology device with anti-mask.
B. Reduces false alarms by sensing both heat and physical motion.
C. 60’ x 80’ standard coverage.
D. Can be mounted between 7’-10’ with no adjustments.
E. Provide with appropriate mounting hardware.
F. White.
   1. Shall be Bosch Security, model number ZX938Z

2.5 PANIC AND DURESS BUTTONS
A. Stainless steel
B. DPDT contacts for connecting to multiple systems
C. Fully supervised
D. Reset key for testing and resetting alarms
E. Recessed latching button to prevent accidental activation
F. Coordinate exact mounting location with Owner prior to purchase and installation
G. Manufacturer:
   1. Shall match County standards.

2.6 AUDIBLE ALARM
A. To be determined (TBD).

2.7 DEVICE CABLE TYPES BY USE
A. Door Contacts, Panic/Duress Buttons: 22-gauge, two-conductor, unshielded, stranded cable shall be provided for all door contacts. The cable shall be white in color and plenum rated (West Penn, General Cable, and Genesis). Door contact cabling shall not exceed 500 feet from the nearest panel.
B. Motion Detectors: 22-gauge, four-conductor, shielded, stranded cable shall be provided for all motion detectors. The cable shall be white in color and plenum rated (West Penn, General Cable, and Genesis). Motion detector cabling shall not exceed 500 feet from the intrusion alarm expansion model or nearest alarm panel on 22-guage.
C. Keypads: 18-guage, four-conductor, non-shielded, non-twisted, stranded cable shall be provided for keypads. The cable shall be white in color and plenum rated (West Penn, General Cable, and Genesis). Keypad cabling shall not exceed 1000 feet from the intrusion alarm expansion model or nearest alarm panel on 18-guage.

D. Follow manufacturer’s recommendations for all systems cabling.

PART 3 - EXECUTION

3.1 TESTING
A. Refer to Section 28 05 00 for additional requirements.

3.2 TRAINING
A. Refer to Section 28 05 00 for additional requirements.

3.3 WARRANTY
A. Refer to Section 28 05 00 for additional requirements.
B. Contractor shall guarantee all materials, equipment, etc., for two (2) years from date of substantial completion of work. This guarantee shall include labor, material, and travel time.
C. All Intrusion Alarm systems, materials, and labor shall be under warranty for 1 year from date of final acceptance.

3.4 GENERAL
A. Prerequisites
1. The Contractor shall maintain a competent (single point of contact) project supervisor, along with competent technical personnel acceptable to the Owner and Consultant, during the entire installation process. Best efforts shall be made to avoid change of the project supervision during the project without prior written approval from the Owner and/or Consultant.
2. The Contractor installing any equipment/devices shall be responsible for providing all interconnecting cables to and/or between same equipment that may be required to make equipment fully operational.

B. Requirements and Responsibilities
1. The Contractor shall provide, furnish, deliver, transport, erect, install, configure, and connect completely all of the material and equipment described herein or depicted on project drawings. The Contractor shall supply all other incidental material required, such as interconnecting cables, to make the work complete, and to install all systems in a turnkey operating condition.
2. Perform this work in accordance with acknowledged industry and professional standards and practices, existing build conditions, and as specified herein. Proved and install all materials, devices, components, and equipment for complete, operational systems.
3. Coordinate all efforts and verify field conditions with those of related trades. In the event of any conflicts, delays or improper preparatory work by others, notify the Owner or Owner’s Consultant: The Owner and Owner’s Consultant’s decision will be binding.

3.5 INSTALLATION PRACTICES
A. All services provided shall be professional and conform to the highest standards for industry practices. The Owner and Owner’s Consultant reserve the right to halt any installation due to poor workmanship. All work shall be defect free, and the installer shall replace, at their expense, any work found to be defective.
B. The Contractor shall exercise care during installation - damage to cables or equipment will not be accepted. The Contractor shall remove any damaged cabling or equipment and replace with new.
C. Contractor is responsible for providing a complete and functional intrusion alarm system.
D. Contractor shall provide low voltage power and control lines to and from power supplies, remotely controlled equipment, and other devices, even though not explicitly indicated on drawings or listed in equipment tables.

E. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.

F. The Contractor shall follow these standards and approved submittals for locations of power supplies. The Owner intends to limit the number and location of power supplies to facilitate more effective long-term support and maintenance of the system.

G. The Contractor shall provide rack shelves or rack mounting ears for any equipment that is not rack mountable. All equipment installed using shelves shall be fastened to the rack shelf.

H. Install plates as required on back boxes where they exist. Provide cut-in back boxes where boxes do not exist.

I. Install surface mounted cable raceway systems that match the surface color and/or the other surface mounted raceways, where cables cannot run within fishable walls.

J. The Contractor installing any RF devices shall be aware that RF devices may cause interference to equipment, and shall take whatever precautions necessary to avoid causing interference.

K. The Owner will provide programming information needed to help Contractor with configuration of system. The Contractor shall have the responsibility to program the system, assure proper communications between controlling points and any monitoring companies, and to adjust any system or device causing false alarm conditions.

L. The Contractor shall be responsible for interfacing to existing alarm system as required by the Owner. Programming the alarm system with codes and zones will be done by the Owner or their contractor.

M. Consideration shall be given not only to operation efficiency, but also to overall aesthetic factors.

3.6 COORDINATION

A. Contractor shall provide up to 4 hours (up to two, 2-hour sessions) of scheduled and dedicated coordination time to assist Owner with sequence of operation, zone coordination, rule creation and coordination as requested by Owner or Consultant.

3.7 TRAINING

A. Provide system operations, administration, and maintenance training by factory-trained personnel qualified to instruct.
   1. Provide printed training materials for each trainee, including product manuals, course outline, workbook or student guides, and written examinations for certification.
   2. Provide hands-on training with operational equipment.
   3. Training shall be oriented to the specific system being installed under this contract as designed and specified.
   4. Contractor shall provide all necessary documentation of system operating parameters prior to scheduled training sessions.

3.8 SUPPORT

A. The Contractor shall make available technical resources, as deemed necessary by the Owner, for database integration projects.

3.9 AESTHETICS

A. All cables terminating at the panel frames shall be vertically straight, with no cables crossing each other, from twelve inches inside the ceiling area to the termination block.

B. All cable bundles shall be combed and bundled to accommodate individual termination block rows and panels.
C. A horizontal and vertical alignment for all mounting hardware shall be maintained to provide a symmetrical and uniform appearance to the distribution frame.
D. All surface-mounted devices shall be firmly secured and level.

3.10 HARDWARE LAYOUT
A. Hardware positioning and layout shall be according to project drawings.

3.11 DEVICE CABLELING/WIRING INSTALLATION PRACTICES
A. Contractor shall coordinate with the Electrical Contractor their requirements for conduits and proper AC power to service all equipment installed by Contractor, in locations where power is not available.
B. Contractor shall provide for proper ground system to all equipment.
C. Each cable group that can cause interference to another group shall be separated by sufficient distance so as not to cause signal contamination or interference.
D. All external wire and cables shall be supported at least every five feet from the structure, or as required to maintain not more than 12" cable sag between supports and without over tensioning the cables.
E. All cables, regardless of length, shall be marked with indelible color-coded labels within 18" of both ends with an identifier that is keyed to the door, room, or corridor number as identified. Labels shall be directly hot stamped or factory stamped, closed sleeve method. Adhesive strip labels may only be used if protected by transparent heat-shrink tubing. There shall be no unmarked cables at any place in any part of any system. Marking codes used on cables shall correspond and be shown clearly on as-built drawings.
F. Each cable shall be marked at all cable ends with a standard nomenclature (Device, #, closet letter).
G. All cables shall be separated into like groups, according to signal or power levels, and routed separately to eliminate signal contamination and crosstalk - this includes both inside and outside of equipment racks.
H. All cables shall have 6-foot service loops neatly coiled in accessible ceiling. During initial cable rough-in, the Contractor shall have sufficient slack to route anywhere within Telecommunications Room. Coordinate exact panel and power supply mounting locations with Electrical Contractor.
I. Cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame. Velcro straps shall be installed snugly without deforming cable insulation. Cables shall be dressed in a neat and orderly fashion. Any cabling or equipment installation that is deemed unacceptable by the Owner or Consultant shall be replaced or corrected by the Contractor at no additional cost.
J. Cable Ties shall be installed snugly without deforming cable insulation. Ties shall be spaced at uneven intervals not to exceed four feet. No sharp burrs shall remain where excess length of the cable tie has been cut.
K. All cables are to run at right angles to the structure, placed above the ceiling in halls or corridors.
L. Cables shall not run above red iron joist.
M. Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests.
N. Contractor shall notify Owner or Owner’s Consultant immediately if obstruction or hazard is discovered in a pathway provided by others.
O. Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radiiues shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the manufacturer’s rating.
P. No splices shall be installed in any cable.
Q. No security device cabling shall have an accessible disconnect outside of a secured equipment room or within a backbox.
R. Any exterior exposed will be contained in waterproof conduit with the appropriate waterproof fittings.

S. All cables are to run at right angles to the structure, placed above the ceiling in halls and corridors.

T. Contractor shall make every effort to conceal wiring and other apparatus into walls, floors and ceilings, assuming any applicable codes and good engineering practice allows and suggests.

U. All cabling systems installed in public areas shall be installed within walls, ceiling or floors or within surface wiring pathways as dictated by codes and good engineering practices.

V. Contractor shall notify Owner or Owner's Consultant immediately if obstruction or hazard to cable paths are discovered and seek corrective actions.

W. The cables shall be supported by properly insulated wire support hangers, bridal rings, "D" rings, ladder cable tray, or inner duct as may be necessary to support cables.

X. Contractor shall seal any cable penetrations they may use or make where the penetration is part of a firewall or acoustic barrier.

3.12 EQUIPMENT CABINET WIRE AND CABLE INSTALLATION

A. All power cables, control cables, and high level cables shall be grouped to one side of the equipment rack while low level cables grouped to the other side.

B. All equipment rack wiring and cabling shall be neatly laced, and ends dressed with heat shrink tubing, and all cables shall have service loops between the horizontal tie bar and the connection to equipment. Rack cabling shall be adequately supported with tie wraps or Velcro wire wraps, and horizontal support bars to rack frame as it enters or exits the front or back of equipment.

C. All equipment rack wiring and cabling shall be neatly dressed.

D. Rack cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame.

3.13 CONNECTORS/CONNECTIONS

A. Moisture Resistance: All connectors shall be crimped or applied in such a way as to prevent moisture from entering the connector or cable.

B. Preparation: Cables shall be carefully prepared and connectors installed as directed by the manufacturer. Proper stripping devices and crimping tools shall be used.

C. Terminations: Connectors shall be carefully fitted to mating devices on equipment to avoid damage to mating contacts, inserts, or bodies. Specialized terminations shall be made in a neat and secure manner, suited to the service of the wire, and as directed by the manufacturer. In all cases, where the manufacturer specifies the terminations, those terminations shall be used.

D. Termination Testing: The strength of the termination shall be tested by manually pulling on the connector and cable. Any terminations that exhibit movement, loose cable, or insecure connections shall be re-terminated.

3.14 PHYSICAL SECURITY INTEGRATION

A. The intrusion detection system shall be integrated with the electronic access control system and the surveillance system.

1. The access control/intrusion detection interface shall be via an Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.

2. The access control/video surveillance integration shall be via a native Ethernet interface.

3. The video surveillance/intrusion detection interface shall be Ethernet interface. The Contractor shall supply all necessary expansion boards as required.

B. The Contractor shall provide any and all licensing to integrate the systems together including any additional items to be added to the yearly maintenance agreement.
C. Refer to the Electronic Access Control and Video Management System specification sections for specific integration requirements.
D. The Intrusion system shall be time syncing to common NTP server.
E. The Contractor shall set up a meeting between the Owner, Consultant and manufacturer to determine the exact functionality of the integration before the integration starts.

3.15 SPECIAL TECHNIQUES
A. Waterproofing: Contractor shall be responsible for creating a waterproof seal in and around any openings the Contractor creates, or are created by others for use by Contractor, that enter or exist in a structure to the outside environment.

3.16 FIRE STOPPING
A. Fire stopping of openings between floors, fire-rated walls, and smoke-rated walls, created by others for the telecommunication Contractor to pass cable through, shall be the responsibility of the security Contractor. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.
B. Any openings created by, or for Contractor, and left unused, shall be sealed up as part of this work by the telecommunication Contractor.

3.17 TEST REQUIREMENTS FOR DEVICE CABLING
A. Contractor shall perform continuity tests to ensure cables are free of shorts within the pairs, and shall verify cables for continuity, pair validity and polarity, and conductor position.

3.18 SYSTEM TESTING PROCEDURES
A. Prior to energizing or testing the system, ensure the following:
   1. All products are installed in a proper and safe manner per the manufacturer’s instructions.
   2. Dust, debris, solder, splatter, etc., is removed.
   3. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
   4. All products are neat, clean, and unmarred, and parts are securely attached.
B. Contractor shall ensure that each device in the security system is functioning normally and in such a manner as to meet the functional and performance requirements in this specification.

3.19 SYSTEM INSPECTION
A. Contractor shall coordinate with Consultant for inspection after Contractor has completed testing of entire system.
B. Contractor shall have trained Contractor representative and testing equipment on site during inspection to assist with spot verification of tests.
C. Contractor shall demonstrate to Consultant the functionality of the system, including the selection of various display modes and accessing system functions.
D. Contractor shall verify with Consultant the precise positioning of all devices and shall make fine adjustments as requested.

3.20 LABELING
A. Contractor shall neatly label all security devices and cabling at both ends. All labels shall be on project as-built drawings.
B. Contractor shall label both ends of the cable within four (4) inches of the termination with the same label identifier. These will be machine printed, Brady (or equivalent) labels.
C. Panels shall have labels showing cable numbers and far end locations for each cable terminated in the cabinet.

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3.21 DOCUMENTATION
A. Upon completion of the installation, Contractor shall provide full documentation sets to the Consultant for approval. All documentation shall become the property of the Owner.

B. Documentation shall include the items detailed in the subsections below:
   1. Contractor shall provide hard copy and electronic forms of the final test results.
   2. Contractor shall provide a document including the following:
      a. Device label/identifier
      b. Location of each device by room or corridor number

C. Contractor shall provide accurate as-built Construction Drawings. The drawings are to include cable routes and device locations.

D. Consultant will provide floor plans in paper and electronic formats (".dwg," AutoCAD and ".dxf") on which as-built construction information can be added. The Contractor shall modify these documents accordingly to denote as-built information as defined above and then return the documents to the Owner.

3.22 FINAL ACCEPTANCE
A. The Contractor shall demonstrate the following before final approval.
   1. Owner training is complete.
   2. Punch list items are complete.
   3. As-built documentation is complete and submitted to Owner/Consultant.

3.23 CLOSEOUT PROCEDURES
A. Closeout Submittals: Contractor shall provide closeout documentation to the Consultant. The Consultant shall receive the closeout submittals no less than 72 hours prior to the scheduled inspection time.

B. Inspection: Contractor shall be present for the inspection by the Consultant. Contractor shall supply all testing equipment needed to verify compliance with the specifications.

C. Punch List: Work or materials found to be incomplete, of unsatisfactory quality, failing to meet written system specifications, and/or unacceptable to the Consultant, shall be documented by the Consultant and provided to Contractor to rectify.

D. Re-Inspection: If a re-inspection is necessary, the costs of the Consultant’s additional travel, hours, and expenses may be deducted by the Owner from the contract amount due Contractor.

E. Punch List Approval: The punch list shall be considered complete only after having been signed by the Owner and Consultant.

3.24 CLEANING
A. Prior to system final turnover to Owner:
   1. Remove all dirt and debris from equipment racks and equipment rooms.
   2. Clean all equipment filters, vents, and fans.
   3. Clean all enclosures and back box interiors thoroughly before installing plates, panels, or covers.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Site preparation, protection and special precautions.

C. Site clearing and grubbing.

D. Earthwork operations and construction for;

1. Buildings including;
   a. Building foundation wall backfill.

2. Pavement areas including;
   a. Exterior sidewalks.
   b. Pavement areas.

3. Landscape areas.

4. Drain tile aggregate.

E. Acquisition of materials and material balancing, including;

1. Stripping operations and stockpiling of soils to be re-used.

2. Relocation of existing soils on-site for specific uses including;
   a. Topsoil.
   b. Parking lots and drives.

3. Removal (off-site) of soils not to be re-used.

4. Importing approved soils for fill.

F. Excavations.

G. Filling, backfilling, and compaction procedures.

H. Grading.

1.02 RELATED SECTIONS

A. Geotechnical report; bore hole locations and findings of subsurface materials.

B. Section 01 5713 - Erosion and Sediment Controls.

C. Section 02 4113 - Selective Site Demolition.

D. Section 31 1000 - Site Clearing.

E. Section 31 2333 - Trenching and Backfilling.

F. Section 33 1122 - Aggregate Bases.

G. Section 32 1216 - Asphalt Concrete Paving.
H. Section 32 1313 - Exterior Concrete Paving.
I. Section 33 3000 - Sanitary Sewerage Utilities.
J. Section 33 4000 - Storm Drainage Utilities.

1.03 REFERENCES
B. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
E. Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction". Only applicable portions of construction methods and materials apply. References to methods of measurement or payment are not applicable.

1. MN/DOT 3149 Granular Material
F. Minnesota Department of Labor and Industry - Minnesota State Building Code.
G. ASTM D 75 - Standard Practice for Sampling Aggregates; 2009.

1.04 QUALITY ASSURANCE
A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.
B. Conform to all applicable code for materials and installation of the Work of this Section.
C. Verify that survey bench mark and intended elevations for the Work are as indicated.
D. Codes and Standards: Perform excavation work and disposal of debris in accordance with applicable requirements of governing authorities having jurisdiction.
E. All excavations and trenches shall comply with the requirements of 29 CFR 1926, Sub-Part P, "Excavations."
F. The Owner will provide an Independent Testing Laboratory to perform testing and inspection services for quality control testing of the earthwork operations.
G. The Contractor is responsible for coordinating construction schedule and required testing with testing agency prior to start of construction. Contractor shall provide adequate notice and time for geotechnical engineer to perform required tests. No time delays will be allowed for uncoordinated work.
H. Grade Verification:
   1. Refer to "Submittals" and "Field Quality Control" of this Section.
I. Refer to "Field Quality Control" of this Section.
1.05 SUBMITTALS

A. Submit under the provisions of Division One Specifications.

B. Independent Testing Laboratory Test Reports: Submit Independent Testing Laboratory reports which pertain to testing and inspection services performed at the site including but not limited to:

1. Inspections of all building areas prior to any filling to ensure that unsuitable and unstable soils have been completely removed.

2. Inspections of all areas to be paved prior to any filling to ensure that unsuitable and unstable soils have been completely removed.

3. Density tests on suitable subgrade verifying proper subgrade compaction has been achieved.

4. Sieve analyses and moisture-density tests of each type of fill material to be used on site supplied by the Contractor.

5. Density tests as backfilling occurs to ensure that the material is uniformly compacted to conform with the specifications.

6. Observation of proof roll tests and recommendations if proof roll does not pass.

7. Monitoring of settlement of soils and recommendations to the Contractor when construction can resume after primary consolidation of soils has occurred for:
   a. Building areas.
   b. Paved areas.

C. Contractor shall provide the following to aid the Independent Testing Laboratory in performing the required testing:

1. Submit ten (10) pound (4.5 kg) sample of each type of fill to Independent Testing Laboratory, in airtight containers.

2. Provide fully loaded tandem axle dump truck for proof rolling operations. Contractor shall provide truck as many times as necessary, as determined by Geotechnical Engineer, to the satisfaction of the Geotechnical Engineer.

3. Any material samples deemed necessary by the Geotechnical Engineer to verify conformance with the Contract Documents.

D. The Contractor is to employ the services of a Registered Land Surveyor to perform the specified layout work and to prepare a grade verification survey. The grade verification shall be submitted after the date of Substantial Completion, prior to project close out, and prior to the release of retainage.

E. Submit test reports for the following products and materials under the provisions of the Division One Specifications:

1. Sieve analysis of each type of fill material prior to delivery on site.
1.06 PROJECT CONDITIONS

A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.

B. Additional test borings and other exploratory operations may be conducted by a Bidder (at no cost to the Owner), provided the methods and operations are acceptable to the Owner.

C. Protection of Persons: The Owner’s activities will continue about the site during construction. Install barricade fencing (snow fence), as necessary, to provide a safe environment between construction work and pedestrian circulation.

D. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer’s satisfaction and at no cost to the Owner.

E. Existing Utilities:
   1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.
   2. The approximate locations of certain underground lines and structures are shown on the plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.
   3. Locate and mark these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.
   4. Locate, excavate, and expose all existing underground lines in advance of trenching operations.
   5. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.

F. Traffic Control:
   1. Maintain vehicular and pedestrian traffic as required for construction activities.
   2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of the Work.
   3. When working in public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.

G. Cold Weather Protection: See Special Precautions of this section.
PART 2 PROPERTIES

2.01 MATERIALS

A. Building Foundation Wall Backfill:

1. Basement foundation backfill material and backfill in or near water shall be coarse granular material. The granular material shall have less than 50 percent passing the No. 40 sieve and less than 5 percent passing the No. 200 sieve.

B. Sand Subbase - Under exterior sidewalks:

1. A twelve (12”) inch Sand Subbase shall be placed beneath exterior sidewalks. The material shall be MN/DOT 3149.2.D.3 Select Granular Borrow. Coordinate with Exterior Concrete Pavement Contractor.

C. Pavement Areas:

1. Subgrade soils in pavement areas shall meet the minimum requirements for Engineered Fill for the Building Pads.

2. Refer to Specification Section 321122, Aggregate Bases, for aggregate base material.

3. A twelve (12”) inch Sand Subbase shall be placed beneath the asphalt paved parking lot. The material shall be MN/DOT 3149.2.D.3 Select Granular Borrow. Coordinate with Bituminous Pavement Contractor.

D. Fill under Landscaped Areas:

1. Fill under landscaped areas shall consist of existing or imported material, free of gravel larger than three (3”) inches in size, free of debris and organic materials.

E. Topsoil:

1. Topsoil shall be the dark brown to black sandy material, if available, stripped from the site. If stripped topsoil is not suitable or sufficient material is not available on the site, provide topsoil from an approved off-site source.

2. Use topsoil consisting of material removed from the top three (3”) inches to six (6”) inches of soils.

3. The topsoil shall be free of rocks larger than one and one half (1-1/2”) inches in diameter. Use topsoil containing no roots, weed clumps or large clods of soil and free of foreign matter.

4. Stockpile topsoil separate from other excavated material.

5. Refer to the landscape specifications for any special imported topsoil requirements.
F. Drain Tile Aggregate: The aggregate shall meet the requirements MN/DOT 3149.2.H Coarse Filter Aggregate:

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2.02 ACQUISITION OF MATERIALS

A. Insufficient Materials: Provide necessary material from off the site, as approved by the Architect/Engineer and Geotechnical Engineer to complete the Work. The cost of these materials shall be considered part of Base Bid Contract.

B. Exterior Backfill: Clean, on-site materials obtained from the required stripping, contour cutting and excavation may be used for backfill and grading.

C. Subsoil for Site Grading: Clean, on-site materials obtained from the earthwork operations.

D. Under-slab Fill: Obtain from on or off the site as approved by the Laboratory Inspector.

E. Fill: Obtain from on or off the site as approved by the Laboratory Inspector.

F. Borrow pits: Borrow pits will not be permitted on this project.

G. Disposition of Materials

1. Surplus Earth: Unless designated elsewhere for use or disposal on the Owner’s property, surplus earth becomes the property of the Contractor and shall be removed from the Owner’s site. The cost of off-site disposal shall be considered part of the Base Bid Contract.

2.03 MATERIAL BALANCE

A. The Contractor is responsible for determining the quantities of material necessary for completing the Work under this Section. This includes the cost of importing approved fill or exporting excess or unsuitable materials.

PART 3 EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum locations. Verify that survey benchmarks and intended elevations for the Work are as indicated on the Drawings.

B. Identify known underground, above ground and aerial utilities. Stake and flag utility locations. Protect above and below-grade utilities which are to remain.

C. Verify that erosion control devices are in place.

D. Verify limits of construction and accurately locate;

1. Site boundaries.

2. Building perimeter.

3. Paved areas.
3.02 PROTECTION

A. Protect utilities that remain, from damage.
B. Protect trees, plant growth and features designated to remain as final landscaping.
C. Protect benchmarks, existing structures, fences, signs, sidewalks, paving, curbs, and other items indicated on the Drawings to remain.

1. Contractor shall provide shoring, bracing, or other means of support as needed to protect the existing items indicated on the Drawings to remain throughout construction. The cost of shoring, bracing, or other means of support shall be included as part of the base bid contract.
D. Protect proposed building(s), including footings and foundation walls. Contractor shall provide shoring, bracing, or other means of support as needed to protect the proposed building(s) during construction. The cost of shoring, bracing, or other means of support shall be included as part of the base bid contract.

3.03 SPECIAL PRECAUTIONS

A. Dewatering:

1. Prevent surface water and subsurface (ground) water from flowing into excavations and from flooding the site and surrounding area.
2. Do not allow water to accumulate in excavations. Remove water to prevent soil changes detrimental to stability of subgrades. Provide and maintain pumps, well points, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
3. Convey water removed from excavations and rainwater to collecting or run-off areas. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
4. Do not place fill or compacted fill in standing water or over softened soils.
5. The cost of dewatering shall be considered part of the Base Bid Contract.

B. Stability of Excavations:

1. Sidewalls of all excavations shall comply with the most current OSHA regulations and applicable local building codes and ordinances. Shore and brace where adequate sloping is not feasible because of space restrictions or stability of material being excavated.
2. Maintain slopes of excavations in safe condition until completion of backfilling.
3. Soils on site may be sensitive to moisture and may be easily disturbed by construction traffic. Measures to protect subgrade from becoming unstable and maintaining stability of subgrade soils shall be provided. Subgrade stabilization will be incidental to the Contractor. Subgrade stabilization shall be the responsibility of the Contractor.

C. Cold Weather Protection:

1. Protect excavation bottoms and bearing surfaces against freezing when atmospheric temperature is less than 35 degrees Fahrenheit (2 degrees C).
2. Do not allow frost and snow to occur within materials beneath footings and slabs. Protect the soils to prevent freezing until after footings have been poured and until fill has been placed and compacted. Completely remove frost and snow, if present, before the footings are poured and the under-slab fill is placed.

3.04 REMOVALS, CLEARING, AND GRUBBING

A. Refer to Specification Section 02 4113 - Selective Site Demolition.
B. Refer to Specification Section 31 1000 - Site Clearing.
C. Remove pavement and strip topsoil from areas not cleared under the above sections.

3.05 EXCAVATIONS

A. The Contractor shall be solely responsible for determining quantities of fill and waste materials to be handled and for amount of grading to be done in order to completely perform all work indicated on the Drawings. The costs of importing fill and/or exporting excess materials from the site shall be considered part of the Base Bid Contract.
B. Excavate to the lines, grades and slopes as indicated on the Drawings.
   1. The soil corrections shall conform to the recommendations of the soils report and the on-site observations of actual conditions made by the Independent Testing Agency.
   2. The Contractor shall thoroughly review the Geotechnical Report, Grading Plans, and Specifications to determine depth of excavation and any soils correction required. No additional compensation will be given for work that could have been anticipated by reviewing the above documents.
C. Provide temporary drainage where construction interferes with existing drainage.
D. Stabilizing Sides of Excavation: Slope the sides of excavations to a safe angle of repose for materials being excavated. Shore and brace where sloping is not possible because of space restrictions or the stability of the materials being excavated. Maintain the sides of the excavations in a safe condition until the completion of backfilling.
E. Excavation for building:
   1. Excavate and remove all soils to the bottom of tunnel wall along the south and east sides of the library for the installation of waterproofing and a perimeter foundation drain tile system. Backfill with Foundation Wall Backfill material as specified above.
      a. At a minimum the contractor shall oversize excavations at least two (2') feet from the outside of the footing at the footing elevation.
F. Excavation for proposed paving areas:
   1. Excavate and remove all soils with organic content, soft soils, or soils otherwise deemed unsuitable by the Geotechnical Engineer under the proposed pavement areas. No proposed pavements shall bear on soil with questionable bearing capacity.
   2. In cut areas subcut to a point equal to the proposed pavement cross section, including base material and sand subgrade, below finished grade elevations.
3.06 FILLING, BACKFILLING, AND COMPACTION PROCEDURES

A. Coordination: The General and Mechanical Contractors shall cooperate in the digging, backfilling and compacting operations.

B. The Contractor shall be solely responsible for determining quantities of fill and waste materials to be handled and for amount of grading to be done in order to completely perform all work indicated on the Drawings. The costs of importing fill and/or exporting excess materials from the site shall be considered part of the Base Bid Contract.

C. Prior to the placement of fill, the Geotechnical Engineer must inspect and approve the bottom or bearing surface of each excavation.

D. Fill shall not be placed on frozen ground, nor shall filling operations continue when the temperature is such as to permit the layer under placement to freeze.

E. Before placing fill on a slope greater than five (5) horizontally to one (1) vertically (5:1), the Contractor shall, at their option: (a) flatten the existing slope to the extent that it will not be steeper than 5:1; or (b) construct steps in the slope, with the back surface being as nearly vertical as practicable and with the horizontal cuts being made as close together as the slope permits, but with no step being less than ten (10') feet in width.

F. General:

1. Deposit approved fill in uniform layers not exceeding eight (8") inches (loose) thickness. Compact each layer with approved methods and equipment to the minimum specified density.
   a. The fill material, when being compacted, shall contain the moisture content necessary for the required compaction as designated by the Geotechnical Engineer. The soil shall be moisture conditioned to within 2 percent of optimum moisture content. The moisture shall be uniform throughout each layer.

2. Scarify, remove, recompress or otherwise rectify all soft or yielding areas resulting from construction operations, rain or other sources at no additional cost to the Owner.

G. Filling, backfilling and compaction for buildings:

1. The Geotechnical Engineer shall inspect footing excavation bottoms. The contractor shall comply with the required corrective procedures to obtain satisfactory footing excavation bottoms prior to placing footings or backfilling.

2. Employ a placement method that does not disturb or damage foundation perimeter drainage, foundation dampproofing and protective cover.

3. The compacted building pad area shall be brought to true even plane to the base of the sand cushion elevation.

H. Filling, backfilling and compaction for proposed paving areas:

1. Prior to placing fill materials, proof roll subgrade using a loaded truck or similar equipment to detect soft or loose zones where additional excavation depths may be required.

2. In fill areas, bring grade up to underside of granular subbase for pavements.
3. Sand base under pavements:
   a. The Contractor shall be required to provide for a one (1') foot sub-grade layer directly beneath the Class 5 aggregate base on all driveways, sidewalks and parking lot areas to be constructed within the site.
   b. The granular material can be MN/DOT Select Granular Borrow material approved by the Independent Testing Laboratory.

4. Compact and shape the subgrade for its entirety as may be necessary to produce, at the time base is placed, the specified density and stability in the top twelve (12") inches of the subgrade and the grades indicated on the Drawings.

5. Pre-compact entire area to be paved to the specified density just prior to placing stabilized aggregate base for pavements.

6. If test rolling shows any area to be unstable, the Contractor shall, at their expense, scarify the area and aerate or add moisture to the soil as necessary, and recompact the soil to the extent it will be stable when retested by rolling.

7. For roadways and parking areas, refer to Section 32 1122 for stabilized aggregate base.

I. Filling, backfilling and compaction for landscape areas:
   1. Place a minimum of six (6") inches of topsoil at the surface of all landscape areas unless noted otherwise.
   2. Compact topsoil as necessary to prevent settlement without inhibiting vertical drainage and subsequent turf establishment. If over-compaction occurs, the Contractor may be required to scarify soil and re-blade. The depth of the topsoil shall be measured after compaction.

J. Compaction of Trenches for Underground Piping:
   1. General Requirements: Place the fill and compact in connection with the installation of the underground plumbing pipe in the Mechanical Contract as follows:
      a. Exterior: Refer to Section 31 2333 - Trench Excavation and Backfill for Utilities.
      b. Interior: Refer to Mechanical Specifications.

3.07 GRADING
A. General:
   1. The grades shown on the Drawings are proposed finish grades.
   2. Provide surfaces free of debris and building materials. Complete rough grading by blading to reasonably smooth contours with neat, uniform transitions and slopes. Remove stones over one and one half (1-1/2 ") inches in diameter, branches and other vegetation. Ease new grades into surrounding existing grades without awkward or abrupt transitions.

B. Paved Areas:
   1. The Contractor shall grade to the prescribed subgrade elevations.
2. All surfaces shall be finished to such contour that they will not impound surface water.
   a. Rough grade tolerances are as follows:
      1) Surfaces shall not vary by more than five one-hundredths (0.05') foot above or one-tenth (0.10') foot below the subgrade elevations referenced to herein.

C. Landscape Areas:
   1. Rough Grading: Grade subsoil to a minimum elevation six (6") inches below finish grade. Soil most suitable for lawns shall be spread as top layer. Rough grading shall include spreading the material on the site smoothly and evenly with a dozer or equal equipment, leaving it similar to back dragging with a dozer.
      a. Rough grade tolerances are as follows:
         1) Not more than two-tenths (0.20') feet above or below finish grade elevations shown on the drawings.

   2. Finish Grading: Spread topsoil to a minimum depth of six (6") inches and stabilize as indicated on the plans.

   3. Backfill in landscape areas placed against curbing shall be graded flush with the top of curb. Backfill in landscape areas placed against walks or pavements shall be graded flush with the walk or pavement surface on the up gradient side and held down one inch below the walk or pavement on the down gradient side.

D. Protect newly graded areas from traffic and erosion. Repair and re-establish grades in settled, eroded and rutted areas to specified tolerances.

3.08 Compaction Density Requirements

A. Compaction of all fill and backfill shall meet or exceed the following percentages of Standard Proctor Density ASTM D698:
   1. 95 percent below steps and exterior sidewalks.
   2. 95 percent for backfill placed more than three (3') feet below final pavement subgrades.
   3. 100 percent for backfill within upper three (3') feet of final pavement subgrades.
   4. 90 percent below landscape areas.

B. Tests falling below the specified density shall be cause for rejection and will require further compacting or removal and recompacting at the Contractor's expense until the Specification requirements are met. Each lift must be approved before commencing with the next succeeding lift.

3.09 Field Quality Control

A. Refer to Division One Specifications for general requirements for field inspection and testing.

B. Retain the services of a Registered Land Surveyor to prepare a grade verification survey as required in Quality Assurance of this section. This surveyor shall check the subbase elevation after the utilities are installed.
   1. Centerline of streets and drives at fifty (50') foot intervals and slope change locations.
2. Parking lots on a seventy-five (75') foot grid and slope change locations.

3. Landscape areas on a seventy-five (75') foot grids and slope change locations.

4. The surveyor shall supply a letter certifying that the grades are within the specified tolerance range prior to placement of aggregate base and topsoil.

C. Field-testing and inspection shall be performed by qualified parties as specified herein and in accordance with the provisions of Division One Specifications.

D. Conventional testing and inspection services herein describe those items not specifically required by Minnesota State Building Code, but are considered essential to the proper performance of the building systems.

E. Verify that footing bearing surfaces comply with frost depth requirements and report variances in a timely manner.

F. Classification of materials used and encountered during construction will be performed in accordance with ASTM D2488 and ASTM D2487.

1. Inspect each footing and slab subgrade to determine if subgrade materials are acceptable. Perform hand auger borings, soil classifications and dynamic cone penetrometer tests to verify if design-bearing capacity is achieved.

2. Inspect, test and approve excavated soils to be used as backfill materials.

3. Inspect and test backfill operations to insure acceptability of materials being placed, method of placement, thickness of layers and compaction of backfill.

4. Inspect and test backfill operations along foundation walls to ensure acceptability of materials being placed and compacted so that settlement will not occur.

G. The geotechnical testing laboratory shall advise the Owner, Contractor and Architect/Engineer of any materials or operation that in their professional opinion will not produce the specified results. The geotechnical testing laboratory shall perform the following:

1. Observe and evaluate the soil conditions at the bottom of all excavations, determine limits of excavation where applicable and evaluate and document depth and width.

2. Perform analysis for on-site and borrow soils for suitability as backfill.

3. Observe, evaluate and report contractor's operations within context of soil limitations and project requirements.

4. Perform density tests on compacted backfill materials.

5. Compaction testing shall be performed in accordance with ASTM D698.

6. Observe all subgrades and excavation bases below footings and slabs before further construction is performed.

7. All proposed pavement subgrades shall be test rolled in accordance with MN/DOT 2111 immediately prior to placement of aggregate base course.

   a. All pavement areas shall be test rolled in the presence of the Geotechnical Engineer.
b. The required subgrade stability shall be such that during placement of the base, rutting and displacement does not occur. Maximum yield: One (1") inch (measured from the top of the constructed subgrade to the bottom of the rut).


H. If tests indicate that the Work does not meet the specified requirements, remove the Work, replace and retest at no cost to the Owner.

I. Frequency of Tests:

1. Compaction tests of subgrade shall be made at maximum horizontal intervals of fifty (50') feet in each direction, or as directed by Architect/Engineer.

2. Compaction tests of in-place backfill materials shall be made at a maximum vertical interval of twelve (12") inches, and maximum horizontal intervals of fifty (50') feet in each direction, or as directed by the Architect/Engineer.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Remove trees, underbrush, undesirable growths, stumps, roots, etc. from the area to the limits indicated on the Drawings, specified herein, and as required to meet the contract documents.
C. Site clearing operations:
   1. Selective site clearing and grubbing of trees and brush.
   2. Stripping topsoil.
   3. Stockpiling of topsoil.
D. Clearing and protection of vegetation.
E. Removal of existing debris.

1.02 REFERENCES
A. Minnesota Department of Labor and Industry - Minnesota State Building Code.

1.03 RELATED SECTIONS
A. Section 01 5713 - Erosion and Sediment Controls.
B. Section 02 4113 - Selective Site Demolition.
C. Section 31 0000 - Earthwork.
D. Section 31 2333 - Trenching and Backfilling.

1.04 QUALITY ASSURANCE
A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.
B. Conform to all applicable code for materials and installation of the Work of this Section.
C. Verify that survey bench mark and intended elevations for the Work are as indicated.
D. Codes and Standards: Perform excavation work and disposal of debris in accordance with applicable requirements of governing authorities having jurisdiction.
E. Use adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this section.
F. Use equipment adequate in size, capacity and number to accomplish the Work in a timely manner.
G. Comply with requirements of governmental agencies having jurisdiction.
1.05 PROJECT CONDITIONS
A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.
B. Protection of Persons: The Owner’s activities will continue about the site during construction. Install barricade fencing, as necessary, to provide a safe environment between construction work and pedestrian circulation.
C. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer’s satisfaction and at no cost to the Owner.
D. Existing Utilities:
   1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.
   2. The approximate locations of certain underground lines and structures are shown on the plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.
   3. Locate and mark these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.
   4. Locate, excavate, and expose all existing underground lines in advance of trenching operations.
   5. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.
E. Traffic Control:
   1. Maintain vehicular and pedestrian traffic as required for construction activities.
   2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of the Work.
   3. When working in public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION
3.01 PREPARATION
A. Identify required lines, levels, contours and datum. Verify that survey benchmark and intended elevations for the Work are as indicated on the Drawings.
3.02 EXISTING UTILITIES AND BUILT ELEMENTS
A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
B. Protect existing utilities to remain from damage.
C. Do not disrupt public utilities without permit from authority having jurisdiction.
D. Protect existing structures and other elements that are not to be removed.
   1. Protect benchmarks, existing structures, fences, sidewalks, paving, curbs and other items indicated on the Drawings to remain.
E. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated on the Drawings or as necessary to facilitate new construction.

3.03 PROTECTION
A. Protect trees, plant growth and features designated to remain as final landscaping.

3.04 CLEARING AND GRUBBING
A. Selective clearing shall be done in areas designated by the Architect/Engineer. Selective clearing shall consist of removing vegetation, brush, stumps, etc. from the area. Selected trees shall be left standing and care shall be taken to protect trees designated to remain. All debris from this operation shall be disposed of off the Owner’s property. Grubbing will not be required in areas designated for selective clearing.
B. Cutting and removing trees, shrubs, bushes, windfall and other vegetation: Cut brush within six (6") inches of the ground surface. Remove, as directed, any low hanging, unsound or unsightly branches on the trees and shrubs designated to remain.
C. Remove and dispose of stumps, roots and other remains. Remove stumps completely. Stumps from trees north of the upper south parking lot shall be ground to help prevent damage to the existing retaining wall. Backfill depressions resulting from the grubbing operations with suitable material and compact to the specified requirements except in areas to be excavated.
D. Remove timber, stumps, roots and other debris or by-products resulting from the clearing and grubbing operations from the site. If any wood is run through a chipping machine, the wood chips shall be immediately recovered and disposed of off the site.
E. Grubbing operations shall consist of removing and disposing of the stumps, roots and other remains in the construction area in their entirety.

3.05 VEGETATION
A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
B. Do not begin clearing until vegetation to be relocated has been removed.
C. Install substantial, highly visible fences at least 3 feet high (at least 1 m high) to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
D. Vegetation Removed: Do not burn, bury, landfill, or leave on site.

E. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace and maintain until established at no cost to Owner.

3.06 DEBRIS

A. Remove debris, junk, and trash from site.

B. Burning of debris is not permitted on the Owner's property.

C. Remove all waste materials and unsuitable or excess topsoil from the Owner's property.

D. The cost of disposal of waste materials is considered part of the Base Bid Contract.

E. Leave site in clean condition, ready for subsequent work.

F. Clean up spills and wind-blown debris from public and private lands.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Trench Excavation, Backfilling and Compaction as indicated on the Drawings, specified herein; and as needed for installation of underground utilities associated with the Work.

1.02 RELATED SECTIONS
A. Section 01 5713 - Erosion and Sediment Controls.
B. Section 31 0000 - Earthwork.
C. Section 33 3000 - Sanitary Sewerage Utilities.
D. Section 33 4000 - Storm Drainage Utilities.

1.03 REFERENCES
E. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
G. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2015.
H. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
I. Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction". Only applicable portions of construction methods and materials apply. References to methods of measurement or payment are not applicable.
   1. MN/DOT 2575 - Establishing Turf and Controlling Erosion
   J. Minnesota Department of Labor and Industry - Minnesota State Building Code.
   L. ASTM D75 - Practice for Sampling Aggregates; 2009.
1.04 SUBMITTALS
A. Submit under provisions of Division One Specifications.
B. Samples: 10 Lb. sample of each type of fill; submit in air-tight containers to testing laboratory.
C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

1.05 QUALITY ASSURANCE
A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.
B. Conform to all applicable code for materials and installation of the Work of this Section.
C. Verify that survey bench mark and intended elevations for the Work are as indicated.
D. The Contractor is responsible for coordinating construction schedule and required testing with testing agency prior to start of construction.
E. Codes and Standards: Perform excavation work and disposal of debris in accordance with applicable requirements of governing authorities having jurisdiction.
F. All excavations and trenches shall comply with the requirements of 29 CFR 1926, Sub-Part P, “Excavations and Trenches.”
G. Use adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this section.
H. Use equipment adequate in size, capacity and number to accomplish the Work in a timely manner.

1.06 PROJECT CONDITIONS
A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding.
B. The Contractor shall carefully review plans and identify utilities that are to be verified prior to construction.
C. Existing Utilities:
   1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.
   2. The approximate location of certain underground lines and structures are shown on the Plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.
   3. Locate these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.
   4. Locate, excavate, and expose all existing underground lines in advance of trenching operations.
5. The Contractor shall carefully review the plans and identify utilities that are to be verified prior to construction.

6. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.

7. The Contractor shall become familiarized with the existing conditions and be prepared to adequately care for and safeguard themselves and the Owner from damage.

D. Protection of Persons: The Owner's activities will continue in and about the site during construction. Install barricade fencing, as necessary, to provide a safe environment between construction work and owner's activities.

E. Benchmarks and Monuments: Maintain and protect benchmarks and monuments that exist on the site.

F. Protection of Existing Property to Remain: Protect existing equipment and structures which are in the area where the Work will be performed and which are to remain. Repair or replace existing property which is to remain that is damaged by the Work, to the Architect/Engineer's or jurisdictional authority's satisfaction and at no cost to the Owner and the Owner's Representatives.

G. Protecting Trees, Shrubbery and Lawns:
   1. Trees, plants and shrubbery in developed areas and along the trench line shall not be disturbed unless absolutely necessary, and subject to the approval of the Architect/Engineer.
      a. Any such trees, plants and shrubbery necessary to be removed shall be heeled in and replanted.
   2. Where trenches cross private property through established lawns, sod shall be cut, removed, stacked and maintained in a suitable condition until the Architect/Engineer approves replacement.
      a. Topsoil underlying lawn areas shall be removed and kept separate from general excavated materials.

H. Clearing:
   1. Perform all clearing necessary for installation of the complete Work.
   2. Clearing shall consist of removing all trees, stumps, roots, brush and debris in the right-of-way obtained for the Work.
   3. All other material, including trimmings from above, shall be completely disposed of off the site in a satisfactory manner.

I. Removing and Re-Setting Fences:
   1. Where existing fences must be removed to permit construction of utilities:
      a. Remove such fences, and as the Work progresses, reset the fences in their original location and condition. If fence cannot be reset to its original quality, the Contractor is to replace the fence with new material. This is considered part of the Base Bid Contract.
J. Restoration of Disturbed Areas:

1. The Contractor shall restore, to a condition equal to or better than existing, all other structures not specifically mentioned above which are disturbed because of this construction including fences, clothes line posts, mailboxes, yard lights, entrance markers, etc. There will be no additional compensation for this miscellaneous restoration.

2. All work in public right-of-way is to meet City and County standards. The Contractor is to contact the City or County to fully understand the scope of work. No additional compensation will be given for unanticipated work in City or County right-of-way.

3. All surplus waste materials remaining after completion of the backfilling operations shall be disposed of in an acceptable manner within 24 hours after completing the backfill work on each particular pipeline section. Disposal at any location within the project limits shall be as specified, or as approved by the Architect/Engineer; otherwise, disposal shall be accomplished outside the project limits at the Contractor's discretion. The backfilling and surplus or waste disposal operations shall be a part of the Work required under the pipeline installation items, not as work that may be delayed until final cleanup.

4. Surface improvements such as pavement, curbing, pedestrian walks, fencing or turf disturbed by this Contractor outside of the general demolition area shall be repaired or replaced to the satisfaction of the responsible party, i.e., the Owner, Architect/Engineer, City or other governmental body. The improvement shall be restored to the pre-existing condition. Each item of restoration work shall be done as soon as practicable after the completion of installation and backfilling operations on each section of pipeline.

5. The restoration work shall be compensated as part of the Work required under those contract items which necessitated the destruction and/or replacement and repair, and there will be no separate payment for restoration. Any improvements removed or damaged unnecessarily or undermined shall be replaced or repaired at the Contractor's expense.

6. Turf restoration shall be accomplished by sod placement except where seeding is specifically allowed or required.
   a. Topsoil shall be placed to a minimum depth of six (6") inches under all sod and in all areas to be seeded. Topsoil shall be salvaged from the demolition areas and shall be light, friable loam, free of heavy clay, coarse sand, stones, sticks and other foreign matter.
   b. All turf establishment work shall be done in substantial compliance with MN/DOT 2575.

7. Pavement Restoration (except in City or County right-of-way).
   a. The in-place pavement structure (including base aggregates) shall be restored in kind and depth as previously existed, using base aggregates salvaged from the excavated materials to the extent available and needed and with new materials being provided for reconstruction of the concrete or bituminous surface courses.
b. Reconstruction of aggregate base courses and concrete or bituminous surface courses shall be in substantial compliance with all applicable MN/DOT Specifications pertaining to the item being restored. The material used shall be comparable to those used in the in-place structure and the workmanship and finished quality shall be equal to that of new construction to the fullest extent obtainable in consideration of operational restrictions.

c. Existing concrete and bituminous surfaces at the trench wall shall be sawed or cut with a cutting wheel to form a neat edge in a straight line before surfaces are to be restored. Sawing or cutting may be accomplished as a part of the removal or prior to restoration at the option of the Contractor. However, all surface edges will be inspected prior to restoration.

K. Minimizing Silting and Bank Erosion During Construction:

1. During construction, protective measures shall be taken and maintained to minimize silting and bank erosion of creeks and rivers adjacent to the Work being performed during construction.

2. Sack breakers, silt fence, biologs or slope stabilizer mats are to be used on steep slopes along creek banks and fill slopes to prevent washing of ditch. The above-mentioned items are to be used at the direction of the Architect/Engineer, local government body or the Watershed District. All costs are part of the Base Bid Contract.

3. The Contractor is to refer to Section 01 5713 - Erosion and Sediment Controls.

PART 2 PRODUCTS

2.01 EXCAVATED MATERIALS

A. Perform all excavations of every description and of whatever substances encountered to depths indicated on the Drawings or as specified.

B. Pile materials for backfilling in an orderly manner at a safe distance from banks or trenches to avoid overloading and to prevent slides or cave-ins.

C. Remove and deposit unsuitable or excess materials in a legal manner off-site. This is considered part of the Base Bid Contract.

2.02 GRANULAR MATERIALS

A. Granular materials furnished for foundation, bedding, encasement, backfill, or other purposes as may be specified shall consist of any natural or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use.

2.03 GRANULAR MATERIAL GRADATION CLASSIFICATIONS

A. Granular materials furnished for use in foundation bedding in areas where the geotechnical engineer indicates that foundation bedding is required shall conform to MN/DOT 3149.2.H Coarse Filter Aggregate.

B. Granular materials required for use as backfill in wet or submerged conditions shall be coarse sand with less than 50 percent of the particles by weight passing the #40 sieve and less than 5 percent of the particles by weight passing the #200 sieve.
C. Granular bedding provided for plastic pipe and fittings where a foundation bedding or coarse sand is not required, as specified above, shall meet the requirements of MN/DOT 3149.2.B.2 Select Granular Material. The pipe shall be installed and bedded in accordance with ASTM D2321. The granular materials shall be placed 6-inches below the bottom of the pipe to a point 12-inches above the top of pipe.

2.04 GRANULAR MATERIAL DESIGNATIONS

A. Granular materials provided for foundation, bedding, encasement or backfill use as required by the Plans, Specifications and Special Provisions, either as part of the pipe item work unit or as a separate Contract Item, shall be classified as to use in accordance with the following:

<table>
<thead>
<tr>
<th>Material use Designation</th>
<th>Zone Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granular Foundation</td>
<td>Placed below the bottom of pipe grade as replacement for unsuitable or unstable soils or to achieve better foundation support.</td>
</tr>
<tr>
<td>Granular Bedding</td>
<td>Placed below the pipe prior to pipe installation and around the pipe to a depth of 12-inches over the pipe to facilitate proper shaping and to achieve uniform pipe support.</td>
</tr>
<tr>
<td>Backfill</td>
<td>Placed below the surface base course, if any, as the second stage of backfill, to minimize trench settlement and provide support for surface improvements.</td>
</tr>
</tbody>
</table>

2.05 PIPE STABILIZATION MATERIALS

A. The materials for base stabilization shall be sand-gravel material or binder stone as described in these Specifications. The type of material to be used is as specified herein.

1. Sand-Gravel Material:
   a. This material shall be used for pipe bedding and/or trench backfill wherever peat, clay or other unsuitable bearing material is encountered as determined by the Architect/Engineer. It shall be clean, granular material with gravel larger than one (1") inch (where used as pipe bedding) and not more than 50 percent passing the No. 40 sieve. The material shall be composed such that proper compaction under the “Specified Density Method” (ASTM D698) is achieved.
   b. The material shall be placed to a depth as determined by the Architect/Engineer, with a minimum depth of six (6") inches below the bottom of the pipe and extending at least one (1') foot beyond the sides of the pipe and one (1') foot above the pipe.

2. Binder Stone:
   a. Binder stone shall consist of durable crushed stone or graded aggregate. All materials shall pass a one and one-half (1½") inch sieve and shall be retained on a three-fourth (3/4") inch sieve. This material shall be used for pipe bedding and/or roadway restoration as directed by the Architect/Engineer.
2.06 OTHER MATERIALS
A. Provide and install other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect/Engineer. This includes City or County right-of-way work.

2.07 SOURCE QUALITY CONTROL
A. Refer to Division One specifications for general requirements for testing and analysis of soil material.
B. Where fill materials are specified by reference to a specific standard, testing of samples for compliance will be provided.
C. If tests indicate materials do not meet specified requirements, change material and retest.
D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION
A. Identify required lines, levels, contours, and datum locations.
B. Locate, identify, and protect utilities that remain and protect from damage.
C. Notify utility company to remove and relocate utilities.
D. Examine the areas and conditions under which the Work of this section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 COLD WEATHER OPERATION
A. No pipe shall be placed when the temperatures fall below 30° Fahrenheit, without approval of the Architect/Engineer.

3.03 OFF SITE DISPOSAL
A. The Contractor will be required to dispose of all bituminous, concrete and other undesirable debris to an approved landfill located outside the project limits with no direct compensation made therefore.

3.04 CLASSIFICATION AND DISPOSITION OF MATERIALS
A. Excavated materials will be classified for payment only to the extent that the removal of materials as classified as rock, by the Architect/Engineer, will be paid for separately from other unclassified materials as an Extra Work Item. All other materials encountered in the excavations will be considered as Unclassified Excavation and no additional compensation will be provided for removal of wood, debris, boulders, stone, masonry, concrete or rock fragments less than one (1) cubic yard in volume, together with other miscellaneous matter that can be removed effectively with power-operated excavators without resorting to drilling and blasting.
B. Rock excavation is defined to include all hard, solid rock in ledge formation, bedded deposits and unstratified masses; all natural conglomerate deposits so firmly cemented as to present all the characteristics of solid rock; and any boulder stone, masonry or concrete fragments exceeding one (1) cubic yard in volume. Materials such as shale, hard pan, soft or disintegrated rock which can be dislodged with a hand pick or removed with a power-operated excavator will not be classified as rock excavation.

C. Excavated materials will be classified by the Independent Testing Lab for re-use as being either suitable or unsuitable for backfill or other specified use, subject to selective controls. All suitable materials shall be reserved for backfill to the extent needed and any surplus remaining shall be utilized for other construction of the project as may be specified or ordered by the Architect/Engineer. To the extent practicable, granular materials and topsoil shall be segregated from other materials during the excavating and stockpiling operations so as to permit best use of the available materials at the time of backfilling. Material handling as described above shall be considered part of the Base Bid Contract with no additional compensation provided.

D. All excavated materials reserved for backfill or other use on the project shall be stored at locations approved by the Architect/Engineer that will cause a minimum of inconvenience to public travel, adjacent properties and other special interests. The material shall not be deposited so close to the edges of the excavations creating hazardous conditions, nor shall any material be placed so as to block the access to emergency services. All materials considered unsuitable by the Laboratory Inspector or Architect/Engineer, for use on the project, shall be immediately removed from the project and be disposed of as arranged for by the Contractor at no extra cost to the contract.

3.05 SHEETING AND BRACING

A. Sheet and brace trenches in accordance with Chapter 66, Trench Bracing, of the Minnesota Regulations relating to Industrial Safety, to a safe angle of repose. The angle of repose shall be no less than the repose required by the Accident Prevention Division of the Minnesota State Industrial Commission or the requirements of the Occupational Safety and Health Act (OSHA), whichever is more restrictive.

B. The Contractor, to prevent the disturbance or settlement of adjacent road surfaces, structures or other improvements, shall furnish and install all sheeting and bracing necessary to provide good working conditions and prevent damage and delay to the Work. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.

C. Bracing shall be so arranged as to provide ample working space and so as not to interfere with the Work and so as not to place any strain on the structures being constructed until such structures are of ample strength to withstand such strain. All sheeting and bracing, unless otherwise specified or ordered to be left in place by the Architect/Engineer, shall be removed from the Work at no additional compensation.

D. Any damage to Work under this Contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins or other causes due to failure or lack of sheeting and bracing or improper bracing, through negligence or fault of the Contractor in any manner, shall be repaired by the Contractor without delay.

E. The Contractor shall be solely responsible for the safety of the excavation relating to angle of repose and/or bracing.
3.06 TRENCH EXCAVATION

A. Notify Architect/Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Work shall be done by open trench excavation except jacked or augered pipe designated on the plans or as directed by the Architect/Engineer, City or County.

C. Topsoil shall be stripped from the trench and stockpiled for reuse over all disturbed areas to be seeded or sodded. Stripping, stockpiling and respreading topsoil will be considered part of the Base Bid Contract.

D. Trench excavation shall be dug to the alignment and depth shown on the plans and only one hundred (100') feet in advance of the pipe laying. The trench shall be braced and drained so that workmen may work safely and efficiently therein.

E. Trench water shall be drained from the trench into natural drainage channels or storm sewers, if acceptable, and shall be considered part of the Base Bid Contract. Draining trench water into sanitary sewers will not be permitted. Prior to draining trench water directly into any natural drainage channel or storm sewer, the Contractor is to contact the proper City, County and State agencies to obtain permission. Dewatering operations shall be monitored for sedimentation and treated prior to discharge to public storm water conveyance systems.

F. Braced and sheeted trenches shall be put in place and maintained as may be required to support the side of the excavation and to prevent any movement which may in any way endanger personnel or injure or delay the Work or endanger adjacent buildings or other structures. Where sheeting and bracing are used, the trench width shall be increased accordingly. Trench sheeting shall remain in place until the pipe has been laid, tested for defects and repaired if necessary, and the earth around it compacted to a depth of one (1') foot over the top of the pipe. It shall be the Contractor's responsibility for compliance therein.

G. Excavated material shall be piled in a manner that will not endanger the Work and that will avoid obstructing sidewalks, driveways and drainage. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

H. The maximum width of the trench at the top of the pipe shall be thirty six (36") inches or two times the pipe diameter plus eighteen (18") inches, whichever is greater.

I. Unless otherwise specified on the plans, all pipes shall be placed in a flat bottom trench with tamped backfill. The sides of the trench shall slope back to provide a stable slope for the particular type of soil in the trench.

J. If the trench is excavated to a greater width than authorized, the Architect/Engineer may direct the Contractor to provide a higher class of bedding, a higher strength pipe or both, than that required by the Contract, without additional compensation therefor, as the Architect/Engineer may deem necessary to satisfy the design requirements.

K. Faulty grade of the trench below grade lines shall be corrected with approved material thoroughly compacted without additional compensation to the Contractor.

L. When excavation is encountered that is unsuitable for backfill, it shall be removed as directed by the Geotechnical Engineer.

M. The Contractor shall be solely responsible for the safety of the excavation relating to angle of repose and/or bracing.
3.07 PREPARATION OF SOIL DURING PIPE LAYING

A. At the time of pipe placement, the bedding conditions shall be such as to provide uniform and continuous support for the pipe between bell holes. Bell holes shall be excavated as necessary to make the joint connections, but they shall be no larger than would be adequate. No pipe material shall be laid in water or when the trench or bedding conditions are otherwise unsuitable or improper.

B. If trench bottom conditions are encountered which appear to require stabilization, the Architect/Engineer shall be informed. The trench conditions shall be examined by the Independent Testing Lab to determine the nature of such instability. If it is determined that the trench bottom cannot support the pipe, a further depth and/or width shall be excavated and refilled to the pipe foundation grade with granular foundation material and thoroughly compacted.

C. If the examination by the Architect/Engineer reveals that the above described conditions are caused by the Contractor's manipulation of the soils in the presence of excessive moisture or lack of proper dewatering, the Contractor shall take such steps as are necessary to stabilize the trench bottom including the use of pipe support material and improved dewatering methods. In such case, the cost of necessary measures shall be borne by the Contractor.

D. When the bottom of the trench consists of material suitable to properly support the pipe, the following methods of bedding shall apply:

1. Granular bedding material shall be placed below the midpoint of the pipe, prior to the pipe installation, to facilitate proper shaping and achieve uniform pipe support, using hand compaction methods.

2. Granular backfill material at the pipe zone shall be free from rock, boulders or other unsuitable substances and shall be deposited into the trench simultaneously on both sides of pipe for the full width of the trench in six (6") inch lifts thoroughly compacted to a minimum elevation of one (1') foot above the top of the pipe. Compaction shall be accomplished by mechanical tamping.

3. The backfill material shall be placed to the top of the trench of subgrade elevation in level, successive layers, having a thickness of not greater than twelve (12") inches. Each successive layer shall be thoroughly compacted as specified prior to the placement of additional layers. If the specified compaction is not being attained utilizing the equipment and materials available, the thickness of the layers shall be reduced. The addition of water to the backfill materials should be limited to achieving satisfactory moisture content for compaction control, if necessary. Compaction of the backfill should be attained using vibratory, non-vibratory or mechanical rammer-type compactors. The type of compactor is dependent on the type of backfill material used. Precautionary measures should be taken to assure that the compaction equipment will not damage the underlying pipe.

4. Backfilling shall not take place at any time unless approved compaction equipment is available at the site.
E. Ledge rock, boulders and large stones shall be removed to provide a clearance of at least six (6") inches below the outside barrel of the pipe or fittings, and to a clear width of six (6") inches on each side of the pipe and appurtenances for pipes sixteen (16") inches or less in diameter; for pipes larger than sixteen (16") inches, a clearance of nine (9") inches below and a clear width of nine (9") inches on each side of outside diameter of pipe shall be provided. Adequate clearance for properly jointing pipe laid in rock trenches shall be provided at bell holes. All costs associated with removing and disposing of ledge rock, boulders and large stones are considered part of the Base Bid Contract.

F. Excavations below subgrade in rock or in boulders shall be refilled to subgrade with material approved by the Independent Testing Lab and thoroughly compacted.

G. Where trench excavation is encountered which is unsuitable for backfill, such material shall be replaced with granular backfill to be supplied by the Contractor at the direction of the Independent Testing Lab. All costs of importing granular backfill are part of the Base Bid Contract.

H. Where pipes are of sufficient size to create an excess of backfill material, the excess shall be hauled off the site. Hauling and grading of the excess backfill will be considered part of the Base Bid Contract.

I. Any deficiency in the quantity of material for backfilling the trenches or for filling depressions caused by settlement shall be supplied by the Contractor with no extra compensation allowed.

J. Backfill in trenches in areas to be paved shall be placed to an elevation that will permit the placement of base and surfacing materials.

K. Trench backfill in pavement areas shall be placed in lifts no greater than eight (8") inches thick, at a moisture content within two (2) percentage points of optimum, to a compacted relative density of at least 95 percent of Standard Proctor Density ASTM D698 at depth, with the upper three (3') feet compacted to 100 percent of Standard Proctor Density.

L. Trench backfill in unpaved areas shall be placed in lifts no greater than twelve (12") inches thick, at moisture content within two (2) percentage points of optimum and compacted to a relative density of at least 90 percent of Standard Proctor Density.

M. Trench backfill compaction around all utility structures shall be accomplished as follows:

1. Within five (5') feet of all utility structures, backfill compaction by mechanical roller vibrators will not be allowed, but shall be accomplished by using whatever mechanical means the Laboratory Inspector deems appropriate and shall be compacted in layers with material not to exceed eight (8") inches in depth.

3.08 FIELD QUALITY CONTROL

A. Refer to Division One specifications for general requirements for field inspection and testing.

B. Field-testing and inspection shall be performed by qualified parties as specified herein and in accordance with the provisions of Division One Specifications.

C. Conventional testing and inspection services herein describe those items not specifically required by State Building Code, but are considered essential to the proper performance of the building systems.

D. Classification of materials used and encountered during construction will be performed in accordance with ASTM D2487 and ASTM D2488.
E. Perform compaction density testing on compacted fill in accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938.

F. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 (Standard Proctor).

G. Document presence of ground water within excavations. Verify cut and fill slopes if specified in the Contract Documents.

H. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner or the Owner's Representative.

I. Frequency of Tests:
   1. Compaction tests shall be performed at the rate of one (1) test per one hundred (100') feet of trench or portion thereof and two (2) tests at each structure with one (1) test below the upper three (3') feet of backfill and one (1) test in the upper three (3') feet of backfill. The majority of the trench backfill tests shall be below the upper three (3') feet.

J. Proof roll compacted fill surfaces within trenches.

K. The Contractor shall make, or provide for, all repairs and replacements to improvements affected by settlement of backfill within 30 days after notice from the Architect/Engineer or the Owner.

3.09 CLEAN-UP

A. Remove unused stockpiled materials; leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Sub-grade preparation.
C. Testing rolling equipment and procedures.
D. Aggregate base course.
E. Coordination with earthwork specification.
F. All installations related to the above materials.

1.02  RELATED SECTIONS
A. Section 02 4113 - Selective Site Demolition.
B. Section 31 0000 - Earthwork.
C. Section 31 1000 - Site Clearing.
D. Section 32 1216 - Asphalt Concrete Paving.
E. Section 32 1313 - Exterior Concrete Paving.

1.03  REFERENCES
D. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2015.
E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.
F. ASTM D 75 - Standard Practice for Sampling Aggregates; 2009.
G. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012.
H. Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction". Only applicable portions of construction methods and materials apply. References to methods of measurement or payment are not applicable.
   1. MN/DOT 3138 - Aggregate for Surface and Base Courses
I. All Materials and Products Used Shall Comply With Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction".
1.04 QUALITY ASSURANCE

A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

B. Conform to all applicable code for materials and installation of the Work of this Section.

C. Verify that survey bench mark and intended elevations for the Work are as indicated.

D. The Contractor is responsible for coordinating construction schedule and required testing with testing agency prior to start of construction.

E. General: In addition to other specified conditions, comply with the following minimum requirements:

1. Subcontractor's Qualifications: The construction of the stabilized aggregate base shall be done by a responsible Subcontractor having the necessary equipment and experience to perform the work.

F. Governing Codes: The Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations and orders of any public authority having jurisdiction. All work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

G. Grade Verification:

1. Refer to "Submittals" and "Field Quality Control" of this Section.

1.05 SUBMITTALS

A. Submit under the provisions of Division One Specifications.

1. Samples: Submit ten (10) pound (4.5 kg) sample of aggregate base course material to the Independent Testing Laboratory.

2. Certificates: The Contractor shall jointly provide certificates certifying that materials comply with the specification requirements.

B. The Contractor is to employ the services of a Registered Land Surveyor to perform the specified layout work and to prepare a grade verification survey. The grade verification shall be submitted prior to installation of pavements and prior to the release of retainage.

1.06 PROJECT CONDITIONS

A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.

B. Protection of Persons: The Owner's activities will continue about the site during construction. Install barricade fencing (snow fence), as necessary, to provide a safe environment between construction work and pedestrian circulation.
C. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer's satisfaction and at no cost to the Owner.

D. Existing Utilities:

1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.

2. The approximate locations of certain underground lines and structures are shown on the plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.

3. Locate and mark these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.

4. Locate, excavate, and expose all existing underground lines in advance of trenching operations.

5. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.

E. Traffic Control:

1. Maintain vehicular and pedestrian traffic as required for construction activities.

2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of the Work.

3. When working in public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.

F. Grade Control: Establish and maintain the required lines and grades, including crown and cross slope, for each course during construction operations.

1.07 WARRANTY

A. Provide one (1) year warranty. Warranty shall be in addition to, and run concurrent with, other warranties required by the Contract Documents, including the Division One Specifications. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under the requirements of the Contract Documents.

B. Warranty: All materials and workmanship provided are guaranteed against defects after completion and final acceptance of the Work. Defects due to faulty materials or workmanship developed during the guarantee period shall be satisfactorily repaired or replaced by the Contractor at their expense.
PART 2 PRODUCTS

2.01 AGGREGATE BASE MATERIALS
A. Stabilized Aggregate Base: Aggregate shall meet the requirements of MN/DOT Specification 3138, gradation Class 5, containing up to 100% recycled aggregate, minimum 10 percent crushed.

PART 3 EXECUTION

3.01 EXAMINATION
A. Examine the areas and conditions under which the Work of this Section will be performed. Correct conditions detrimental to the timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

B. Verify substrate has been inspected, gradients and elevations are correct, and at suitable moisture content.
   1. Do not proceed until unsatisfactory conditions have been corrected.

C. Coordinate with the related specification 31 0000 Earthwork to confirm that the sub-grade is at the proper elevation, densities, and material types. Proceeding with work indicates acceptance of the conditions constructed by the related specification section.

3.02 SUBGRADE PREPARATION
A. Correct irregularities in the substrate gradient and elevation by scarifying, reshaping, and recompacting.

B. Do not fill on soft, muddy, or frozen surfaces.

C. Remove loose and foreign material from compacted subbase surfaces immediately before paving application. Do not disturb subbase material.

3.03 TEST ROLLING SUBGRADE
A. Test rolling shall be used when verifying stability and uniformity of subgrade. This procedure shall be performed in presence of testing laboratory inspector.

B. Use test rolling equipment conforming to the following description:
   1. Tandem axle, dual wheel dump truck.
   2. Tire width maximum of 17 inches for the front axle tires.
   3. Tire width maximum of 11 inches for the rear axle tires.
   4. Tire pressure shall be no less than 2 psi of tire or vehicle manufacturer’s maximum psi rating. The minimum psi rating must be 80 psi.
   5. Minimum legal capacity of 52,000 pounds.
   6. Minimum front axle capacity of 20,000 pounds.
   7. Front axle is loaded to a minimum of 16,000 pounds.
   8. Minimum gross weight is a minimum of 50,000 pounds.
9. Provide weigh slip to testing laboratory inspector.

C. Test Rolling Procedures shall be performed as follows:

1. Operate equipment at a rate not to exceed 2.5 to 5 mph or a comfortable walking pace.

2. Adjust speed to allow testing laboratory inspector to measure any deflections and areas of rutting.

3. Operate proof roller equipment in a pattern so that affected areas are loaded with at least one pass.

4. After proof rolling, check subgrade for conformance to drawings, and correct all surface irregularities. Re-shape subgrade within tolerances specified.

D. Limited access areas

1. The above description is typical for road and walk construction. Some areas use of a roller may be impractical, use largest compaction equipment that is practical under the observation of the soils testing representative.

E. Test Rolling Evaluation:

1. Rutting up to 1-inch is acceptable. Rutting in excess of 1-inch but not more than 6-inches shall be considered a failure and will require that soil be reworked and compacted to required density.

2. Deflection (Pumping):
   a. For granular & non-granular materials, deflection is acceptable to a maximum of six-tenths (0.6 in) inches.
   b. For aggregate surfacing, full-depth reclamation, aggregate base, and shoulder aggregate base, deflection is acceptable to a maximum of four-tenths (0.4 in) inches.
   c. For stabilized full depth reclamation, deflection is acceptable to a maximum of three-tenths (0.3 in) inches.

3. Rutting and deflection in excess of 6-inches will require review and recommendation for corrective action by an approved Geotechnical Engineer.

4. Any failing test creates a hold point, where no additional may be placed until Corrective action and passing retest(s) have occurred, or accepted by the Engineer. Any additional material placed before corrective action and passing retest(s) occur constitutes as unauthorized work per MN/DOT 1512.2.

5. After remedial work is performed, a final test roll shall be performed the day following the completion of compaction per MN/DOT 2215. If remedial work is performed as directed, a second test roll may be required at discretion of testing laboratory inspector.

3.04 AGGREGATE BASE PLACEMENT

A. Subgrade: The area to be paved shall be graded to the elevation of the underside of the stabilized base. Pre-compact soils beneath the stabilized base to 100 percent of Standard Proctor Density ASTM D698. Recompact as necessary to provide the specified density for the subgrade.
B. Remove all castings set by others that are within the paving area and replace with metal covers. The castings shall be reset as outlined in 321216 Asphalt Concrete Paving and 321313 Exterior Concrete Paving.

C. Spread aggregate base over prepared base to a total compacted thickness as indicated on the Drawings.

D. Place aggregate base in maximum three (3") inch layers and roller compact.

E. Level and contour surfaces to elevations and gradients indicated on the Drawings.

F. Compact placed aggregate materials to achieve compaction to 100 percent of its Standard Proctor Density ASTM D698.

G. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

H. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

I. Use mechanical vibrating tamping in areas inaccessible to compaction equipment.

J. Aggregate base shall be placed under the concrete curb and gutter by the Paving Contractor. Coordinate all work with the Exterior Concrete Pavement Contractor.

3.05 TOLERANCES

A. Flatness: Maximum variation of one-fourth (1/4") inch measured with a ten (10') foot straight edge.

B. Scheduled Compacted Thickness: Within one-fourth (1/4") inch.

C. Variation from True Elevation: Within one-fourth (1/4") inch.

3.06 FIELD QUALITY CONTROL

A. Field testing and inspection shall be performed by qualified parties as specified herein and in accordance with the provisions of Division One Specifications.

B. An Owner hired testing laboratory shall perform tests as indicated below.

   1. Perform one sieve analysis on the aggregate base in accordance with ASTM C136/C136M for every 1000 tons of aggregate base or a minimum of one test.

   2. Visually field verify by test rolling and take two field density tests in accordance to ASTM D1556/D1556M or ASTM D6938 for every 250 tons of aggregate base placed or a minimum of four tests.

C. Grade Verification of Aggregate Base: A grade verification survey shall be performed after the aggregate base has been installed. This should be on the same grid system as specified in Section 31 0000 Earthwork "Field Quality Control". The surveyor shall issue a letter certifying that the grades are within the specified tolerances prior to installation of pavements.

D. If tests indicate that the Work does not meet the specified requirements, remove the Work, replace and retest at no additional cost to the Owner.

END OF SECTION
SECTION 32 1216
ASPHALT CONCRETE PAVING

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Asphalt concrete paving above aggregate base course; as indicated on the drawings, specified herein, and complete with all accessories.
C. Bituminous tack coat
D. Asphalt concrete paving; wear course and non-wearing course surfaces.
   1. Parking lot pavement.
   2. Driveway pavement.

1.02  RELATED SECTIONS
A. Section 310000 - Earthwork.
B. Section 321122 - Aggregate Bases.
C. Section 32 1313 - Exterior Concrete Paving.

1.03  REFERENCES
A. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; 2015.
F. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2017.
G. Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction". Only applicable portions of construction methods and materials apply. References to methods of measurement or payment are not applicable.
   1. MN/DOT 3138 - Aggregate for Surface and Base Courses
   2. MN/DOT 3139 - Graded Aggregate for Bituminous Mixtures
   3. MN/DOT 3151 - Bituminous Material
   4. MN/DOT 2357 - Bituminous Tack Coat
   5. MN/DOT 2360 - Plant Mixed Asphalt Pavement
H. All Materials and Products Used Shall Comply With Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction".

1.04 QUALITY ASSURANCE

A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

B. Conform to all applicable code for materials and installation of the Work of this Section.

C. Verify that survey bench mark and intended elevations for the Work are as indicated.

D. The Contractor is responsible for coordinating construction schedule and required testing with testing agency prior to start of construction.

E. General: In addition to other specified conditions, comply with the following minimum requirements:

   1. Subcontractor’s Qualifications: The construction of bituminous paving shall be done by a responsible Paving Subcontractor having the necessary equipment, plant and experience to perform the work.

F. Governing Codes: The Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations and orders of any public authority having jurisdiction. All work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

G. Grade Verification:

   1. Refer to "Submittals" and "Field Quality Control" of this Section.

1.05 SUBMITTALS

A. Submit under the provisions of Division One Specifications.

   1. Samples: Submit thirty-five (35) pound (4.5 kg) sample of asphalt concrete paving materials and asphalt mix design to the Independent Testing Laboratory.

   2. Certificates: The Contractor and the Asphalt Concrete Producer shall jointly provide certificates certifying that materials comply with the specification requirements.

   3. Job Mix Design: The bituminous mix plant shall have on file a report prepared by an approved testing laboratory that indicates the proportions of materials used in each type of bituminous courses being provided and the temperature of the mix. The job mix design shall be submitted to the Architect/Engineer for acceptance prior to placing the bituminous mix.

B. The Contractor is to employ the services of a Registered Land Surveyor to perform the specified layout work and to prepare a grade verification survey. The grade verification shall be submitted after the date of Substantial Completion, prior to project close out, and prior to the release of retainage.
1.06 PROJECT CONDITIONS

A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.

B. Protection of Persons: The Owner’s activities will continue about the site during construction. Install barricade fencing, as necessary, to provide a safe environment between construction work and pedestrian circulation.

C. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer's satisfaction and at no cost to the Owner.

D. Existing Utilities:
   1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.
   2. The approximate locations of certain underground lines and structures are shown on the plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.
   3. Locate and mark these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.
   4. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.

E. Traffic Control:
   1. Maintain vehicular and pedestrian traffic as required for construction activities.
   2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of the Work.
   3. When working in public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.

F. Grade Control: Establish and maintain the required lines and grades, including crown and cross-slope, for each course during construction operations.

G. Weather Limitations:
   1. Apply bituminous tack coat only when the ambient temperature is at least 50 degrees Fahrenheit (10 degrees C), and when the temperature has not been below 35 degrees Fahrenheit (2 degrees C) for twelve (12) hours immediately prior to application.
   2. Do not apply materials when the base surface is wet or contains an excess of moisture which would prevent uniform distribution and the required penetration.
3. Construct asphalt concrete surface course only when atmospheric temperature is above 40 degrees Fahrenheit (4 degrees C), when the underlying base is dry and when weather is not rainy.

4. Refer to “Minimum Placement Temperature Chart” prepared by the National Asphalt Pavement Association for minimum bituminous placement temperatures.

5. Paving shall not take place when, in the opinion of the Independent Testing Laboratory, the weather or surface conditions are considered unfavorable.

1.07 MATERIAL REQUIREMENTS

A. Mix Criteria:

1. Provide mix formulas for each required asphalt-aggregate mixture.

2. Establish a single percentage of aggregate passing each required sieve size, a single percentage of asphalt cement to be added to aggregate, and a single temperature at which asphalt concrete is to be produced.

3. Comply with the mix requirements of the Minnesota Department of Transportation (MN/DOT) standards.

4. Maintain material quantities within allowable tolerances of the governing standards.

B. Prepare and keep on file the mix formula for each course.

C. The base course shall be tested and approved by the Independent Testing Laboratory immediately prior to placement of the asphalt concrete course.

D. The Contractor will be responsible for all drainage of the finish surface. Any “bird baths” will be considered unacceptable and shall be remedied by the Contractor at their expense to the satisfaction of the Architect/Engineer.

1.08 SYSTEM DESCRIPTIONS

A. Design Requirements:

1. Bituminous Pavements: Design consists of a minimum of twelve (12”) inches of Select Granular Borrow, six (6”) inch thick aggregate base course, a minimum two (2”) inch thick asphalt non-wear course, and a minimum two (2”) inch thick asphalt wear course.

2. Concrete Curb and Gutter: Refer to plan detail.

1.09 WARRANTY

A. Provide one (1) year warranty. Warranty shall be in addition to, and run concurrent with, other warranties required by the Contract Documents, including the Division One Specifications. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under the requirements of the Contract Documents.

B. Warranty: All materials and workmanship provided are guaranteed against defects after completion and final acceptance of the Work. Defects due to faulty materials or workmanship developed during the guarantee period shall be satisfactorily repaired or replaced by the Contractor at their expense.
PART 2 PRODUCTS

2.01 AGGREGATE BASE MATERIAL
A. Reference related specification section 32 1122 - Aggregate Bases

2.02 ASPHALT CONCRETE MATERIALS
A. Bituminous Tack Coat: The bituminous tack coat shall be RC liquid asphalt or emulsified asphalt. The tack coat shall meet the requirements of MN/DOT Specification 2357.
B. Bituminous Material for mix shall meet the requirements of MN/DOT 3151, PG (Performance Grade) 58-28 for all non-wear virgin and recycled non-wear or wear and PG 64-28 for all virgin mix wear layers.
C. Non-wear Course Mix: MN/DOT 2360, Type SP; thickness indicated on "System Description" of this Section.
   1. Mixture shall conform to current DOT requirements.
D. Wear Course Mix: MN/DOT 2360, Type SP; thickness indicated on "System Description" of this Section.
   1. Mixture shall conform to current DOT requirements.

2.03 GRADED AGGREGATES FOR BITUMINOUS MIXTURES
A. Graded aggregates shall conform to MN/DOT 2360.
B. Gradation shall conform to:
   1. Non-wear Course: MN/DOT 2360, Gradation B.
   2. Wear Course: MN/DOT 2360. Gradation A.

2.04 SOURCE QUALITY CONTROL
A. Provide mix design for asphalt under the provisions of Division One Specifications.
B. Submit proposed mix design of each class of mix for review and approval prior to commencement of the Work.
C. Test samples in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION
A. Examine the areas and conditions under which the Work of this Section will be performed. Correct conditions detrimental to the timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.
B. Coordinate with the related specification sections 31 0000 Earthwork and 32 1122 Aggregate Bases to confirm that the sub-grade is at the proper elevation, densities, and material types. Proceeding with work indicates acceptance of the conditions constructed by the related specification section.
3.02 SURFACE PREPARATION

A. Sub-grade
   1. Reference related specification Section 31 0000

B. Aggregate Bases
   1. Reference related specification Section 321122

C. Remove loose and foreign material from compacted subbase surfaces immediately before paving application. Do not disturb subbase material.

3.03 TACK COAT:

A. Apply to contact surfaces of previously constructed portland cement concrete surfaces and similar surfaces.

B. Apply at rate of five-hundredths (0.05) to fifteen-hundredths (0.15) gallons per square yard of surface.

C. Apply tack coat by brush to contact surfaces of concrete curbs, gutters, manholes and other structures projecting into or abutting asphalt concrete pavement.

D. Allow surfaces to dry until material is at condition of tackiness and ready to receive pavement.

3.04 PLACING THE MIX - DOUBLE COURSE

A. Place asphalt concrete mixture on prepared surfaces; spread and strike-off using paving machine.

B. Inaccessible and small areas may be placed by hand if approved by the Civil Engineer. Prior to hand placement, the Contractor shall contact the Engineer to obtain written permission to proceed.

C. Place each course at thickness so that when compacted it will conform to the indicated grade, cross-section, finish thickness and density indicated.

D. Pavement Placing:
   1. Unless otherwise directed, begin placing non-wear course at high side of section on one-way slope.
   2. After first strip has been placed and rolled, place succeeding strips.
   3. Complete non-wear courses for a section before placing wearing courses.
   4. Place mixture in continuous operation as practicable.
   5. Place tack coat before placing wear course.
   6. Non-wear course shall be swept as required before placing wear course.

E. Hand Placed:
   1. Spread, tamp and finish mixture using hand tools in areas where machine spreading is not possible, as acceptable to the Geotechnical Engineer.
   2. Place mixture at a rate that will ensure handling and compaction before mixture becomes cooler than acceptable working temperature.
F. Joints:

1. Gradually make joints between old and new pavements, or between successive day's work, to ensure a continuous bond between adjoining work.

2. Construct joints to have same texture, density and smoothness as adjacent sections of asphalt concrete course.

3. Clean contact surfaces free of sand, dirt or other objectionable material and apply tack coat.

4. Offset transverse joints in succeeding courses not less than five (5') feet.

5. Cut back edge of previously placed course to expose an even, vertical surface for full course thickness.

6. Offset longitudinal joints in succeeding courses no less than six (6") inches.

7. When the edges of longitudinal joints are irregular, honeycombed, or inadequately compacted, cut back unsatisfactory section to expose as even, vertical surface for the full course thickness.

3.05 COMPACTING THE MIX

A. Provide sufficient number of rollers to obtain the required pavement density of 93 percent for non-wear and 92 percent for wear course mix and no more than 97 percent on any layer based on the maximum specific gravity in accordance to the gyratory mix design.

B. Begin rolling operations as soon after placing mix when the mixture will bear weight of roller without excessive displacement.

C. Do not permit heavy equipment, including rollers, to stand on finished surface before it has thoroughly cooled or set.

D. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

E. Start rolling longitudinally at extreme lower side of sections and proceed toward center of pavement. Roll to slightly different lengths on alternate roller runs.

F. Do not roll centers of section first under any circumstances.

G. Breakdown Rolling:

1. Accomplish breakdown or initial rolling immediately following rolling of transverse and longitudinal joints and outside edge.

2. Operate rollers as close as possible to the paving machine without causing pavement displacement.

3. Check crown, grade and smoothness after breakdown rolling.

4. Repair displaced areas by loosening at once with lutes or rakes and filling, if required, with hot loose material before continuing rolling.
H. Second Rolling:
   1. Follow breakdown rolling as soon as possible, while mixture is hot and in condition for compaction.
   2. Continue second rolling until mixture has been thoroughly compacted.

I. Patching:
   1. Any patching of defective areas shall be discussed with the Civil Engineer prior to proceeding with work.
   2. Remove and replace defective areas.
   3. Cut-out and fill with fresh, hot asphalt concrete.
   4. Compact by rolling to specified surface density and smoothness.
   5. Remove deficient areas for full depth of course.
   6. Cut sides perpendicular and parallel to direction of traffic with edges vertical.
   7. Apply tack coat to exposed surfaces before placing new asphalt concrete mixture.

3.06 MANHOLE AND GATE VALVE PROTECTION
A. Cover manholes, catch basins and gate valves lying within the surface to be sealed to as to prohibit the bituminous material from being placed thereon.
B. Clean the surface of these structures following the application of the cover aggregate.

3.07 ADJUSTING CASTINGS
A. Castings shall be raised after the bituminous base course is placed and prior to installing the wear course.
B. The bituminous base shall be saw cut around the cover plate. The bituminous aggregate and cover plate shall be removed.
C. The casting shall be set to final grade using adjusting rings and mortar. No blocks will be allowed.
D. The aggregate base shall be placed to the design depth around the casting. The bituminous patch mix shall be placed and tamped around the casting to bring the grade up to the surface of the bituminous base.
E. The final grade of castings in paved areas shall be one-fourth (1/4") inch to one-half (1/2") inch below the top of the completed wear course. The castings shall be set to the contour of the finished surface so that the required tolerance is uniform around the circumference of the casting. The one-fourth (1/4") inch to one-half (1/2") inch tolerance shall be measured at the immediate edge of the casting and no “straightedge” measurements shall be accepted. A plywood template, one-half (1/2") inch thick, shall be fastened to the top of all non-adjustable castings during placing and rolling of the wear course to ensure that the required tolerances are met.
F. All final adjustments to the adjustable castings shall be made by means of the casting adjustment bolts.
G. All castings, which do not meet the required tolerances, shall be removed and re-adjusted at the Contractor's expense.

3.08 FIELD QUALITY CONTROL

A. Field testing and inspection shall be performed by qualified parties as specified herein and in accordance with the provisions of Division One Specifications.

B. An Owner hired testing laboratory shall perform tests as indicated below. Density and thickness requirements listed below apply to the individual cores. Averaging of the individual cores will not be allowed to show compliance with the specified requirements.

1. Perform a minimum of one bituminous mix verification tests for each asphalt concrete layer in accordance with ASTM C136/C136M, ASTM D2172/D2172M and ASTM D2726/D2726M.

2. Perform field density tests and thickness tests on the bituminous paving by taking four (4") inch diameter core samples for every 200 tons or less of bituminous pavement per course to determine the field density and thickness of cores in accordance with ASTM D2726/D2726M and ASTM D3549/D3549M. For larger projects, perform a minimum of two tests for every 500 tons of bituminous pavement placed plus 2 tests every 500 tons thereafter.

   a. Density: Minimum acceptable density of in-place material is 93 percent for non-wear and 92 percent for wear course mix and no more than 97 percent on any layer based on the maximum specific gravity in accordance to the gyratory mix design.

      1) The Owner may require removal and replacement of any part of any lift that is constructed to less than the minimum required density at no cost to the Owner or Owner's representatives.

         (a) Patching or "checker board" replacement will not be tolerated. Additional pavement may be required to be removed and replaced, even pavement conforming to the specified densities, at the Owner's discretion.

      2) The Owner has option to reject all bituminous pavements failing to meet the specified densities. Rejected pavement shall be removed and replace at no additional cost to Owner or Owner's Representatives. Owner shall have the option to require the removal and replacement of all paved areas, including areas that meet the require densities.

         (a) Patching or "checker board" replacement will not be tolerated. Additional pavement will be required to be removed and replaced, even pavement conforming to the specified densities, at the Owner's discretion. Removal and replacement shall be at no cost to the Owner or Owner's representatives.

   b. Average Core Densities: Where the average density of all bituminous placed, per lift, is less than the specified densities (93 percent wear, 92 percent non-wear), the Owner may elect not to accept all of the bituminous pavement, including sections of the pavement that meet the specified density.

   c. Thickness: The in-place compacted thickness of the bituminous core shall be within the following allowable variation from thickness specified herein.

      1) Non-wear course: Plus or minus one-fourth (±1/4") inch.

      2) Wear course: Plus or minus one-fourth (±1/4") inch.

      3) The overall thickness of all lifts shall not be less than three-eighths (±3/8") inch of the total thickness specified.
4) The bituminous pavement thickness indicated is the minimum thickness. No additional payment will be given for pavement that exceeds the indicated thickness.

5) The Owner may require removal and replacement of any part of any lift that is constructed to less than the minimum allowable thickness at no cost to the Owner or Owner's representatives.
   (a) Patching or "checker board" replacement will not be tolerated. Additional pavement may be required to be removed and replaced, even pavement conforming to the specified thicknesses, at the Owner's discretion.

6) The Owner has option to reject all bituminous pavements failing to meet the specified tolerances. Rejected pavement shall be removed and replace at no additional cost to Owner or Owner’s Representatives. Owner shall have the option to require the removal and replacement of all paved areas, including areas that meet the require total thickness.
   (a) Patching or "checker board" replacement will not be tolerated. Additional pavement will be required to be removed and replaced, even pavement conforming to the specified thicknesses, at the Owner's discretion. Removal and replacement shall be at no cost to the Owner or Owner's representatives.

d. Repair holes from test specimens as specified for patching defective work.

C. Surface Smoothness:

   1. The Contractor shall provide final surfaces of uniform texture, conforming to the required grades and cross-sections. Visually observe surface smoothness of finished surface. The finished surface shall be free of segregated, open and torn sections and shall be smooth and true to grade and cross section as shown on the Drawings.

   2. Test finished access drive and/or roadway surfaces for each asphalt concrete course for smoothness, using a ten (10') foot straightedge applied parallel to and at right angles in centerline of paved areas.
      a. Check surfaced areas at intervals as directed by the Geotechnical Engineer.
      b. Surfaces will not be acceptable if exceeding the following:
         1) Base Course: One-fourth (1/4") inch in ten (10') feet.
         2) Surface Course: One-fourth (1/4") inch in ten (10') feet.

D. Flood Test:

   1. After completion, flood the entire asphalt concrete paved area with water by use of a tank truck or hoses.

   2. If a depression or bird bath is found where water ponds to a depth of more than one-sixteenth (1/16") inch, fill areas or otherwise correct to provide proper drainage to the satisfaction of the Owner.

   3. Feather and smooth the edges of fill so that the joint between the fill and the original surface is invisible.
E. Grade Verification of Bituminous Pavement: A grade verification survey shall be performed after the final lift of bituminous pavement has been completed. This will be on the same grid system as specified in Section 321122 Aggregate Bases "Field Quality Control". The surveyor shall issue a letter certifying that the grades are within the specified tolerances.

F. If tests indicate that the Work does not meet the specified requirements, remove the Work, replace and retest at no additional cost to the Owner.

3.09 CLEANING

A. After completion of paving operations, clean surfaces of excess or spilled asphalt materials to the satisfaction of the Architect/Engineer.

3.10 PROTECTION

A. The Contractor shall be required to protect all adjacent concrete surfaces from chipping and damage during the asphalt pavement placement.

B. Protect all concrete surfaces from staining or discoloration during placement of asphalt materials or vehicle trucking during construction.

C. Immediately after placement of asphalt paving, provide traffic cones, barricades and other devices needed to protect pavement and marking paint from mechanical injury for a minimum of seven (7) days.

END OF SECTION
SECTION 32 1313
EXTERIOR CONCRETE PAVING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Exterior concrete pavement systems above base course; as indicated on the Drawings, specified herein, and complete with all accessories.
C. Granular base under exterior concrete sidewalk Work is specified under the provisions of Section 31 0000.
D. Aggregate base under exterior concrete sidewalk Work is specified under the provisions of Section 32 1122
E. Exterior Concrete Work:
   1. Concrete curb and gutter.
   2. Aprons and Driveway slabs.
   4. Concrete pavement.
   5. Pedestrian curb ramps.
   6. Colored Concrete.
F. Concrete Sealer.
G. Joint Sealant and Joint Backing.
H. Special Concrete Finishes; Including sandblasting and horizontal casting.

1.02  RELATED SECTIONS

A. Section 31 0000 - Earthwork.
B. Section 321122 - Aggregate Bases

1.03  REFERENCES

B. ACI 306R - Cold Weather Concreting; 2010.
C. ACI 325.9R - Guide for Construction of Concrete Pavement; 2015.


M. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field; 2015ae1.


Q. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.


U. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

V. Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction". Only applicable portions of construction methods and materials apply. References to methods of measurement or payment are not applicable.

1. MN/DOT 2301 Concrete Pavement

2. MN/DOT 2521 Walks

3. MN/DOT 2531 Concrete Curbing


X. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000 (Reapproved 2009).

Y. ACI 308R - Guide to Curing Concrete; 2016.

Z. ACI 309R - Guide for Consolidation of Concrete, American Concrete Institute; 2005.


AC. ACI 201 - Durability of Concrete.
AD. ACI 211 - Proportioning Concrete Mixtures.

1.04 QUALITY ASSURANCE

A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

B. Conform to all applicable code for materials and installation of the Work of this Section.

C. Verify that survey bench mark and intended elevations for the Work are as indicated.

D. The Contractor is responsible for coordinating construction schedule and required testing with testing agency prior to start of construction.

E. Perform the Work in accordance with ACI 325.9R and ACI 330R.

F. Acquire cement and aggregate from same source for all Work.

G. The complete exterior concrete Work shall give the appearance of uniformity in surface contour and texture and shall be accurately constructed to line and grade. The required joints shall show neat workmanship.

H. The Owner shall employ the services of an independent testing lab to perform the specified field quality control.

I. Quality Control:
   1. Do not commence placement of concrete until mix design has been reviewed and approved by the Architect/Engineer and until copies are at the jobsite, the batch plant and the building inspection department.

J. Governing Codes: The Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations and orders of any public authority having jurisdiction. All work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

K. Grade Verification:
   1. Refer to "Submittals" and Field Quality Control" of this Section.

L. Colored Concrete
   1. Consistency of concrete color is the responsibility of the Contractor. Deviation from sample colors during mock up tests shall be grounds for rejection of the work, solely at the determination of the Architect/Engineer.

   2. The same brand and type of cement shall be used throughout the project. Prior to the mix design being made, the cement intended for use shall be checked to determine that its lightness/darkness is similar to the cement used in the original sample. The colored admixtures shall be added at the standard proportion specified by the manufacturer.

   3. Prior to commencing the placement of concrete, but after acceptance and approval of the mock-up, the contractor shall submit properly labeled and identified samples of materials used in the approved samples as follows:
      a. Coarse Aggregate - 10 pounds
b. Fine Aggregate - 10 pounds

c. Cement - 10 pounds

d. Colored Admixture - 1 pound

e. Curing Compound - 1 pint

4. The samples shall be stored where directed and shall constitute material standards for the project. During construction, one pound of cement from each load of cement delivered to the ready mix plant used in this specific job will be retained and packaged for comparison with retained master sample, dated and stored with retained samples. Aggregate source must be checked periodically and compared with retained samples.

1.05 SUBMITTALS

A. Submit under provisions of Division One Specifications.

B. Submit under the provisions of Division One Specifications.

1. Delivery Tickets: Submit one copy to Architect indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump and time of batching for each load delivered.

2. Product Data: Provide manufacturer's data on joint filler and curing compounds.

3. Test Reports and Mix Designs: Contractor shall submit mix designs and aggregate test reports, directly from testing laboratory. Submit mix designs and aggregate test reports at least 14 days prior to placing. Do not place concrete until the Architect/Engineer has reviewed mix designs and aggregate test reports. Mix identification designation.

4. Colored Concrete: Colored admixture manufacturers complete technical data and installation instructions, including curing requirements.

5. Colored concrete materials as specified herein.

C. The independent testing laboratory will submit concrete compression tests, entrained air test, and slump test reports.

D. The Contractor is to employ the services of a Registered Land Surveyor to perform the specified layout work and to prepare a grade verification survey. The grade verification shall be submitted after the date of Substantial Completion, prior to project close out, and prior to the release of retainage.

1.06 PROJECT CONDITIONS

A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.

B. Protection of Persons: The Owner's activities will continue about the site during construction. Install barricade fencing, as necessary, to provide a safe environment between construction work and pedestrian circulation.
C. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer's satisfaction and at no cost to the Owner.

D. Existing Utilities:

1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.

2. The approximate locations of certain underground lines and structures are shown on the plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.

3. Locate and mark these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.

4. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.

E. Traffic Control:

1. Maintain vehicular and pedestrian traffic as required for construction activities.

2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of the Work.

3. When working in public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.

F. Grade Control: Establish and maintain the required lines and grades, including crown and cross-slope, for each course during construction operations.

G. Cold Weather Protection: Place and protect concrete in accordance with ACI 306R, and the following:

1. When mean daily temperature is 40ºF or lower, provide suitable protection for concrete work as required to maintain minimum concrete temperature of 50ºF for five (5) days, or 70ºF for three (3) days.
   a. So as to avoid thermal shock to the finished work, following protection period, do not allow concrete to cool more than 20ºF each successive day.

H. Hot Weather Protection: Place and protect concrete in accordance with ACI 305R. Employ suitable means to prevent too-rapid drying. Shade fresh concrete as soon as is possible without marring surface.

I. Wet Weather Protection: Do not place concrete in rain, sleet, or snow, without providing adequate protection.
1.07 DELIVERY STORAGE AND HANDLING
A. Furnish delivery tickets with each load of concrete delivered to the Project. Information on each ticket shall be as follows:

1. Name of ready-mix batch plant.
2. Ticket number
3. Date.
4. Truck number.
5. Project name and location.
6. Type of concrete (mix number).
8. Weights of all ingredients.
9. Time loaded or time of first mixing.
10. Maximum aggregate size.
11. Type, brand, and amount of admixtures.
12. Total water in the batch and maximum amount of water that can be added at the site without exceeding design mix proportions.
13. Amount of water added at site and initials of person adding water.
B. The Contractor shall retain delivery tickets for the duration of construction.

1.08 FIELD MEASUREMENTS
A. Verify actual locations of exterior concrete work and other construction to which concrete work must fit, by accurate field measurements before installation. Show recorded measurements on final Shop Drawings. Coordinate installation schedule with construction progress to avoid delay of the Work.
B. The Contractor is to employ the services of a registered land surveyor to perform the specified layout work.

1.09 WARRANTY
A. Provide one (1) year warranty. Warranty shall be in addition to, and run concurrent with, other warranties required by the Contract Documents, including the Division One Specifications. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under the requirements of the Contract Documents.
B. Warranty: All materials and workmanship provided are guaranteed against defects after completion and final acceptance of the Work. Defects due to faulty materials or workmanship developed during the guarantee period shall be satisfactorily required or replaced by the Contractor at their expense.
PART 2  PRODUCTS

2.01  MATERIALS

A. Cement

2. Use only one type and brand of Portland Cement for all exposed concrete. Architect's permission is required to change brands.

B. Aggregates

1. Fine and coarse aggregates for normal weight structural and non-structural concrete: ASTM C33/C33M.
2. Maximum nominal size of coarse aggregate shall be ¾” for all concrete.
3. Limits for deleterious substances and physical properties of coarse aggregate for concrete shall meet the requirements of ASTM C33/C33M, 3/4”, Class 5S.

C. Water: Clean and free from deleterious amounts of acids, alkalis or organic materials.

D. An air entraining admixture, conforming to ASTM C260/C260M, shall be used for all concrete.

E. (Colored Concrete) Integral Color:

1. The color-conditioned admixture shall be single-component, pigmented, water reducing, concrete admixture, factory formulated and packaged in cubic yard increments. It shall comply with UBC Standard No. 26-9. Color shall be prepackaged to the weight of cement per cubic yard and according to the color approved in the mock-up sample.

2. Acceptable manufacturers are:
   a. “Chromix”, by L.M. Scofield Company

2.02  ACCESSORIES

A. Curing Materials

1. Moisture-Retaining Cover: ASTM C171, waterproof paper or polyethylene film.
2. Liquid Membrane Curing Compound: ASTM C309, Type 2, Class B.

B. Form Release Agent: Commercial product to facilitate stripping without staining or damaging concrete or impairing future concrete treatment.

C. Expansion Joint and Isolation Joint Filler: ASTM D1751, preformed, resilient, non-extruding, asphalt impregnated joint filler, 1/2” thick unless otherwise indicated.

D. Provide granular cushion material under all other exterior concrete slabs as specified under the provisions of Section 31 0000.

E. Provide stabilized aggregate base under all concrete curb and gutter as specified under the provisions of Section 321122 Aggregate Bases.

F. Provide stabilized aggregate base under all concrete pavements as specified under the provisions of Section 321122 Aggregate Bases.
G. Pavement Joint Sealing Compound:

1. Provide silicone joint sealant meeting the requirements of ASTM D5893/5893M and the following:
   a. Primer-less.
   b. Low modulus.
   c. Does not contain solvents or diluents that can cause shrinkage or expansion during curing.
   d. Smooth and uniform in appearance with a consistency that allows application with air pressure guns or hand caulking applicators.
   e. Capable of withstanding repeated joint movement from negative fifty (-50) to one hundred (100) percent without losing adhesion to the concrete and without cohesion failure.

2. Joint Backing: As recommended by sealant manufacturer.

H. Evaporation Retardants

1. An evaporation-retarding agent may be used during the concrete finishing operation to control plastic cracking of the fresh concrete.

2. Acceptable materials are:
   a. “Confilm”, by Master Builders
   b. “Eucobar”, by Euclid Chemical Co.

I. Colored Concrete: Curing compound shall conform to ASTM C309, be colored and compatible with the colored concrete and acceptable to the color admixture manufacturer. Acceptable manufactures are:


2.03 PRODUCTS

A. Concrete Walks: MN/DOT Spec 2521, as detailed and dimensioned on the Drawings.

B. Concrete Curb/Gutters: MN/DOT Spec 2531, as detailed and dimensioned on the Drawings.

C. Exterior on-grade Concrete Pavement: MN/Dot Spec 2461, as detailed and dimensioned on the Drawings.

2.04 CONCRETE MIXES

A. Provide mixes meeting the following minimum requirements. Submit concrete mix design for each type of concrete. Mix designs must be reviewed prior to pouring concrete. Review is for conformance with specification requirements only. Contractor is responsible for performance.

1. 28-day Compressive Strength: 4,500 psi.

2. Maximum Aggregate Size: 3/4", ASTM C33/C33M Class 5S.


4. Slump Range: 2"-5".
5.    Air Content ASTM C231: 6.5% ±1-1/2%

6.    Maximum Water/Cement Ratio:
    a.    0.42 for unreinforced concrete.

B.    Concrete shall conform to the requirements of ASTM C94/C94M.

C.    Provide concrete with workability such that it will fill the forms, without voids or honeycombs, when properly vibrated, without permitting materials to separate or excess water to collect on the surface.

2.05 FORM MATERIALS

A.    The forms shall be of metal, wood or other suitable material, and shall be capable of sustaining the concrete in its proper position until set. Do not use aluminum materials in contact with concrete. Concrete form materials must be used in a manner to provide the surface finish specified.

B.    Form Coating Material: Coat forms with a non-staining form release agent that will not discolor or deface the surface of the concrete.

C.    Side forms shall have a height at least equal to the edge thickness of concrete being formed.

D.    Flexible or curved forms shall be used on curves having a radius of 150 feet or less.

E.    Face forms for curbing shall conform to the shape and design of the curb.

2.06 SOURCE QUALITY CONTROL

A.    Provide concrete mix design under the provisions of Division One Specifications

B.    Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of work.

C.    Provide an independent testing laboratory to perform the following:

    1.    At the beginning of the concrete operations for the project and for each 1,000 yards of concrete delivered to the project, test the fine and coarse aggregate gradation in accordance with ASTM C136/C136M for conformance with this specification.

    2.    Verify that the concrete supplied meets the mix design requirements.

    3.    Submit test results to the Architect/Engineer.

2.07 CONCRETE SEALER

A.    Clear Concrete Sealer For Decorative Breezeway Concrete: Water-borne, modified emulsion, leveling ability, semi-gloss sealer; “CEMENTONE Clear Sealer” as manufactured by L.M. Scofield Company, or approved equivalent by the Architect/Engineer.

PART 3 EXECUTION

3.01 EXAMINATION

A.    Examine the areas and conditions under which the Work of this Section will be performed. Correct conditions detrimental to the timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.
B. Coordinate with the related specification sections 31 0000 Earthwork and 32 1122 Aggregate Bases to confirm that sub-grade, granular base, and aggregate base is at the proper elevation, densities, and material types. Proceeding with work indicates acceptance of the conditions constructed by the related specification section.

3.02 SURFACE PREPARATION
A. Sub-grade
   1. Reference related specification Section 31 0000
B. Aggregate Bases
   1. Reference related specification Section 321122
C. Base Placement
   1. Spread granular cushion as specified in Section 31 0000 over prepared base to a total compacted thickness as indicated on the Drawings.
   2. Place granular cushion base in maximum three (3") inch layers and roller compact.
   3. Level and contour surfaces to elevations and gradients indicated on the Drawings.
   4. Compact placed aggregate materials to achieve compaction to 100 percent of its maximum dry density in accordance with ASTM D698.
   5. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
   6. Use mechanical vibrating tamping in areas inaccessible to compaction equipment.
D. Remove loose and foreign material from compacted subbase surfaces immediately before paving application. Do not disturb subbase material.
E. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete pavement.
F. The Contractor shall notify the Architect/Engineer and the Independent Inspection Agency a minimum of twenty-four (24) hours prior to commencement of concreting operations.

3.03 FORMING
A. Place and secure forms to correct location, dimension, profile, and gradient.
B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.
D. Install forms to allow continuous progress of Work and so that forms can remain in place at least twenty-four (24) hours after concrete placement.
E. Slipform equipment may be used if the resulting curb and gutter conforms to the shape as specified on the drawings and the finish is satisfactory to the Architect/Engineer.

3.04 JOINTING
A. General Joint Requirements:
   1. All joints shall be vertical and straight.
2. Transverse joints shall be placed at right angles to the longitudinal axis of the Work.

3. Joints shall align with similar joints in adjoining work where practicable.

4. The panels shall be square where practicable.

5. Maximum length to width ratio shall be one and one-half to one (1.5:1).

6. Eliminate or minimize acute angle panels (especially less than sixty (60) degrees) provide reinforcing steel if this is not possible.

7. Unless provided elsewhere in the construction documents (I.E. architectural/landscape plans) contractor shall submit a jointing plan to the architect/engineer prior to start of construction. Jointing plan shall clearly indicate location of control joints, construction joints, and isolation joints.

8. All joint work shall coordinate precisely with grids, modules and radials as prescribed on the Drawings.

B. Expansion/Isolation Joints:

1. Provide isolation joints at the following locations:
   a. At the beginning and end of all curved sections.
   b. Where new concrete surrounds, adjoins or abuts any existing fixed objects, such as fire hydrants, valve boxes, manholes, light poles, flag poles, curbs, walks or other rigid structures.
   c. At sixty (60') foot maximum spacing for sidewalks or as indicated on the drawings.
   d. Between curb and gutter and immediately adjacent slabs behind curb and gutter.

2. Joints shall be filled with one-half (1/2") inch thick pre-formed joint filler material except as noted below.
   a. Joint filler material shall not be provided between concrete slabs and curb and gutter except under the following circumstances.
      1) Where concrete slabs behind the curb and gutter are immediately adjacent to the curb and the concrete extends behind the curb and gutter by more than 12-feet.
      2) Where concrete slabs are constrained from lateral movement by other objects such as asphalt pavement, curbs, or other fixed objects.
   b. Joints and filler material shall be equal in depth to the full thickness of the slab.

C. Contraction (Control) Joints:

1. Curbing shall be provided with contraction joints at ten (10') feet on center or as indicated on the Drawings.

2. Sidewalks shall be provided with contraction joints at a maximum interval of one-half (1.5) times the sidewalk thickness, unless otherwise approved by engineer. (For Example: Four (4") Inch thick sidewalk x one-half (1.5) = six (6') foot joint spacing.)

3. Pavements shall be provided with contraction joints at a maximum interval of twenty-four (24) times the pavement thickness, with a maximum interval of fifteen (15') feet. (For Example: Six (6") Inch thick pavement x twenty-four (24) = twelve (12') foot joint spacing)
D. Hand Tooled Joints:

1. Hand tooled joints shall be provided for the following concrete work:
   a. Sidewalks.
   b. Curbs.

2. All joints and edges, including against isolation/expansion joints, shall be rounded with a one-fourth (1/4”) inch radius tool.

3. Contraction joints in sidewalks shall extend to at least twenty-five (25%) percent of the sidewalk thickness. (t/4)

4. Contraction joints in curbs shall extend to at least two (2”) inches deep.

5. Contraction joints shall be approximately one-half (1/2”) inch wide.

E. Sawcut Joints:

1. Sawcut joints shall be provided for the following concrete work:
   a. Pavements.

2. Sawcut joints shall extend to at least twenty-five (25%) percent of the pavement thickness. (t/4)

3. Contractor shall sawcut joints as soon as concrete is hard enough such that sawing does not ravel joint edges or dislodge coarse aggregate particles. The maximum time to wait prior to sawing shall twelve (12) hours or less.

3.05 PLACING CONCRETE

A. Place concrete in accordance with ACI 330.1 and comply with the requirements for mixing and placing concrete as herein specified.

B. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.

C. Immediately before concrete placement, dampen base to reduce absorption. Standing water will not be permitted.

D. Do not place concrete on frozen ground.

E. Incorporate all concrete admixtures into the concrete at the ready-mix plant.

F. Reject concrete not placed within 90 minutes of initial mix.

G. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

H. Place concrete to pattern indicated on the Drawings or as directed by the Architect/Engineer.

I. Place concrete by methods that prevent segregation of the mix. Consolidate concrete along the face of the forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement and side forms.

J. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
### 3.06 CONCRETE FINISHING

A. After striking off and consolidating concrete, smooth surfaces by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.

B. After floating and before final finishing, check the concrete with a ten (10') foot steel straightedge to ensure there is no variation greater than three-sixteenth (3/16") inch from the straightedge.

C. Work edges of slabs, gutters top edge of back of curbs and formed joints with an edging tool, and round to one-half (1/2") inch radius, unless otherwise indicated. Eliminate tool marks on concrete surfaces.

D. After completion of floating and when excess moisture or surface sheen has disappeared, complete troweling and finish surfaces as follows:
   1. Sidewalks: Light broom, radius edges to one (1") inch and trowel joint edges.
   2. Curb and Gutters: Light broom.
   3. Straight Curbs: Light broom, radius edges to one (1") inch and trowel joint edges.
   4. Inclined Ramps: Light broom perpendicular to slope.
   5. Pavements: Light broom.

### 3.07 CONCRETE CURING

A. Unformed Surfaces: Apply curing materials as soon as finishing operations are complete and the concrete's sufficiently hard to be undamaged by the curing process.
   1. Waterproof paper or polyethylene film: Use appropriate color of film based on ambient temperature. Sprinkle concrete with water as necessary during application of covering. Lap edges and ends at least 6 inches, and seal laps. Weight down covering to prevent movement. Patch holes and tears that occur during the curing period.

B. Compound Application:
   1. Apply a membrane-curing compound to the exposed surface of the concrete within one (1) hour of finishing the concrete.
   2. The compound shall be thoroughly mixed before it is applied.
   3. If forms are removed in less than seventy-two (72) hours after placing the concrete, the curing compound shall be applied immediately to the exposed surfaces.
   4. The curing compound shall be applied by an approved airless spraying machine at the approximate rate of one (1) gallon of compound to 150 square feet of surface curing area.
   5. In all cases, the Contractor shall be responsible for the protection of the concrete from frost during the cure period.

C. The Architect/Engineer will shut down concrete placement if the operations are not being carried out according to these specifications.
3.08  PAVEMENT JOINT SEALING
A. Prior to sealing, the joint faces shall be cleaned and dried.
B. Prepare joints and sealing compounds in accordance to the manufacturers installation instructions.
C. Install sealing compounds in accordance with manufacturer's instructions in the following locations;
   1. At all construction and expansion/isolation joints.
D. Top of sealer shall be flush to one eighth (1/8") inches below top of concrete surface.

3.09  FIELD QUALITY CONTROL
A. Conventional testing and inspection services herein describe those items not specifically required by the Minnesota State Building Code, but are considered essential to the proper performance of the building systems.
B. Field testing and inspection shall be performed by qualified parties as specified herein and in accordance with the provisions of Division One Specifications:
   1. Compressive Test Specimens:
      a. Make one set of test cylinders (four per set), per ASTM C31/C31M, for each day's pour in excess of one cubic yard for each type of concrete. If day's pour exceeds 25 cubic yards, make one set of test cylinders for each additional 50 cubic yards or fraction thereof. Mold and store cylinders for laboratory cured specimens.
   2. Compressive Strength Tests:
      a. Test cylinders per ASTM C39/C39M. Testing shall be performed by independent testing lab. One specimen shall be tested at 7 days for information and two cylinders shall be tested at 28 days for acceptance. One specimen shall be retained in reserve for later testing if required.
   3. Slump Tests:
      a. Furnish and maintain a slump cone and tamping rod. Test first batch of each type of concrete delivered for each day's pour, plus one test for each 25 cubic yards or fraction thereof, ASTM C143/C143M.
   4. Entrained Air Tests:
      a. Furnish and maintain a properly calibrated pressure-type air meter. Test first batch of air entrained concrete delivered for each day's pour plus one test for each 50 cubic yards or fraction thereof, ASTM C231/C231M.
C. Grade Verification of Concrete Pavement: A grade verification survey shall be performed after the concrete pavement has been installed. This will be on the same grid system as specified in Section 321122 Aggregate Bases "Field Quality Control". The surveyor shall issue a letter certifying that the grades are within the specified tolerances.
D. Grade Verification of Exterior Walks: A grade verification survey shall be performed after all walks are installed to assure ADA accessibility standards have been satisfied. Replacement of walks is required if installed with over 5 percent longitudinal grade, over 2 percent cross slope, over 2 percent at 90 degree changes in direction (landings) or 1.5 percent within 5 feet of a building entrance.
E. Contractor shall maintain records of placed concrete items. Record date, location of pour, quantity, air temperature and test samples taken.

3.10 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures and mechanical injury.

END OF SECTION
SECTION 32 13 16
DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. SECTION INCLUDES

1. Decorative integrally colored with Specialty finish concrete paving & sealer
2. Decorative integrally colored concrete paving

B. Related Sections:

1. Section 033000 "Cast-in-Place Concrete"
2. Section 321313 "Concrete Paving" for cast-in-place concrete paving with other finishes.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Concrete Mix Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

B. Integral color chart

C. Product Data to achieve light sandblast surface finish

D. Product data for sealer

E. Provide proposed dowel system for joining concrete pours

F. Mock-Up Sample. 4 ft x 12” sample to be placed on site demonstrating the same quality and consistency. Sample to show construction joints, colors, and texture and finish.

A. Other Submittals:
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures.
   4. Curing compounds.
   5. Applied finish materials.

C. Material Test Reports: For each of the following:
   1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.
   1. Architectural Finish Concrete paving to be installed by an architectural concrete contractor with a minimum 10 years experience in installing decorative concrete.
   2. The architectural concrete contractor shall provide 3 – recent 8x10 color photographs of previously installed local projects that are a minimum of 5 years old. The photos should be labeled with project name, project location and date of installation.
   3. The architect will have the option of viewing these previously installed projects to evaluate the overall level of quality and expertise demonstrated by the contractor.

   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

D. Source Limitations: Obtain decorative concrete paving products and each type or class of cementitious material of the same brand from same manufacturer's plant, and obtain each aggregate from single source.

E. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
F. ACI Publications: Comply with ACI 301 unless otherwise indicated.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 10 feet by 10 feet.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Preinstallation Conference: Conduct conference at Project site

1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:
   a. Concrete mixture design.
   b. Quality control of concrete materials and decorative concrete paving construction practices.

2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Decorative concrete paving Installer.
   e. Manufacturer's representative of decorative concrete paving system.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.
2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, white portland cement Type I
   a. Fly Ash: ASTM C 618, Class F.

B. Normal-Weight Aggregates: ASTM C 33, Granite uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.


E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type F
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type F
3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type F.

F. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

1. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

2. Color ‘1': ‘See Landscape Materials Schedule

3. Color ‘2': See Landscape Materials Schedule

4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cemstone
   b. Scofield, L. M. Company, Chromix
   c. Approved Equal

G. Sealers: Color Sealing Compound for Exterior Slabs:

1. Water Based penetrating concrete sealer – Silane syloxane for use with colored concrete or equal

2. Super Diamond Clear by Euclid Chemical for light sandblast finish pattern areas.
2.3 RELATED MATERIALS

A. Joint Fillers: Tear Top Ethafoam Expansion Joint

B. Joint Sealant: Polyurethane Sealant: Sonneborn building Products, Product NP-1 for single component products. Color to be selected from full range of manufactures samples

2.4 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi at 28 days

2. Generally retain first option in first subparagraph below if concrete paving will be exposed to deicers or subject to freezing and thawing while moist; retain second option for concrete required to have low water permeability; insert another ratio to suit Project.

3. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45

4. Slump Limit at point of discharge 7.00 inch, plus or minus 1 inch

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.


2. Use water-reducing and retard ing admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Use fly ash, Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.

G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.5 SPECIAL FINISHES

A. Light Sandblast per pattern shown on drawings
2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction]. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

   1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   2. Butt Joints: Use bonding agent or epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   3. Dowelled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

   1. Locate expansion joints at intervals of 20 feet unless otherwise indicated.
   2. Extend joint fillers full width and depth of joint.
   3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
   4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent decorative concrete paving:

   1. Sawed Joints: Form contraction joints with power saws equipped with diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      a. Tolerance: Ensure that sawed joints are within 3 inches in both directions from center of dowels.
   2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and at isolation joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, mesh reinforcement, and items to be embedded or cast-in. Project curbs and other adjacent work.
B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

K. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
3.6 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Compound: Apply curing compound immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after application. Maintain continuity of coating, and repair damage during curing period.

1. Cure integrally colored concrete with a pigmented curing compound.

F. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

G. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

H. Scoring: Score decorative jointing in paving surfaces 1/8 inch deep with diamond V blades to match pattern indicated. Rinse until water is clear. Score after finishing operations are complete.

1. Joint Width: 1/ 8" x 1/ 8"

3.7 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 1/4 inch (19 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/4 inch (13 mm).
4. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
5. Vertical Alignment of Dowels: 1/4 inch (6 mm).
6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
7. Joint Spacing: 3 inches (75 mm).
8. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
9. Joint Width: Plus 1/8 inch (3 mm), no minus.
3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. M or fraction thereof of each concrete mixture placed each day.

   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Decorative concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
I. Prepare test and inspection reports.

3.9 REPAIRS AND PROTECTION

A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 16
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Pavement markings; as indicated on the Drawings, specified herein, and complete with all accessories.
   1. Parking bays.
   2. Handicapped symbols.
   3. "No Parking" curb painting.
   4. Miscellaneous pavement markings.
C. Labor, material, equipment, and accessories to complete the Work.
D. Prepare pavement surfaces and furnish and apply traffic paint for pavement striping and marking of proposed parking lots and drives as shown on the Drawings and specified herein.

1.02 RELATED SECTIONS
A. Section 32 1216 - Asphalt Concrete Paving
B. Section 32 1313 - Exterior Concrete Paving

1.03 REFERENCES
A. MN/DOT Approved/Qualified Products: Pavement Marking Materials
B. Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD)

1.04 SUBMITTALS
A. Product Data: Manufacturer’s data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements.
   3. Installation methods.

1.05 PROJECT CONDITIONS
A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.
B. Protection of Persons: The Owner’s activities will continue about the site during construction. Install barricade fencing (snow fence), as necessary, to provide a safe environment between construction work and pedestrian circulation.
C. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer’s satisfaction and at no cost to the Owner.

D. Traffic Control:

1. Maintain vehicular and pedestrian traffic as required for construction activities.

2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of Work.

3. When working in the public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.

E. Weather Limitations

1. No painting shall be performed during the threat of rain or when the pavement surface is damp.

2. Paint shall be applied when the air temperature is between 40°F and 90°F and at least 5°F above the dew point. Paint shall be applied when the relative humidity is 85% or less.

3. The Contractor shall not begin marking pavement surface until conditions are acceptable to the Engineer.

1.06 WARRANTY

A. Provide one (1) year warranty. Warranty shall be in addition to, and run concurrent with, other warranties required by the Contract Documents, including the Division One Specifications. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under the requirements of the Contract Documents.

B. Warranty: All materials and workmanship provided are guaranteed against defects after completion and final acceptance of the Work. Defects due to faulty materials or workmanship developed during the guarantee period shall be satisfactorily repaired or replaced by the Contractor at their expense.

PART 2 PRODUCTS

2.01 ASHPALT MARKING PAINT MATERIALS

A. Low VOC Latex Traffic Marking Paint

1. Contractor to provide paint products meeting the following requirements:
   b. Seal Master - “Traffic Paint.”
   c. Sherwin Williams - “Traffic Paint.”
   d. PPG - “Zoneline Traffic & Zone Marking Paint.”

B. Paint shall be specifically formulated for use as exterior pavement marking paint in traffic areas.
C. Paint shall be white in color unless specified otherwise.
D. Substitutions: Under the provisions of Division One Specifications.

PART 3 EXECUTION

3.01 EXAMINATION
A. Examine the areas and conditions under which the Work of this Section will be performed. Correct conditions detrimental to the timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 SURFACE PREPARATION
A. Lane and parking lot striping shall not be performed until the excess oils in the new asphalt paving have dissipated, allowing a better bond between the paint and asphalt pavement. The Contractor shall wait 3 to 4 weeks after the asphalt pavement has been installed before placing striping.
B. Immediately prior to application of the traffic paint, the surface shall be properly swept.
C. All sweeping operations and disposal of sweepings shall be the responsibility of the Contractor and will be considered incidental to the Contract.

3.03 LANE STRIPING AND ACCESSIBLE MARKINGS
A. Cleaning: Sweep the surface with power broom, supplemented by hand brooms, to remove loose material and dirt.
B. Provide paint striping and handicap logos as indicated on the Drawings. Dimensions shown are to center of stripe unless noted otherwise.
C. Markings: The lines shall be four (4") inches wide unless noted otherwise. The parking stalls shall be the width called for on the Drawings.
D. Paint the International Wheelchair Symbol of Accessibility in each accessible parking stall. The painted symbol on the pavement shall be in accordance with the state code requirements.
E. Access aisles adjacent to accessible parking stalls shall be painted with a minimum of 5 equally spaced hash bars at a 45 degree angle from the adjacent striping.
   1. Where a “No Parking” sign cannot be installed at the head of the access aisle due to obstruction of a curb ramp or pedestrian route, the contractor shall paint a "No Parking" designation on the surface of the access aisle.
F. Application: Paint shall be applied with mechanical equipment according to the manufacturer’s suggested procedure. The applicator shall provide a uniform straight line with sharp edges. Apply two (2) separate coats at a rate of three hundred and twenty (320’) lineal feet of standard four (4”) inch strip per gallon, unless otherwise recommended by the paint manufacturer.

3.04 PROTECTION
A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
3.05 CLEANING

A. Paint containers shall be properly disposed of in accordance with applicable regulatory requirements.

B. When marking paint is thoroughly dry, visually inspect the entire applications, and:

1. Touch up paint as required to provide clean, straight lines and surfaces throughout.

2. Using a permanently opaque paint identical in color to the surface on which the paint was applied, block out and eliminate all traces of splashed, tracked and/or spilled pavement marking paint from the background surfaces.

3. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

4. Remove markings in manner to avoid damage to the surface on which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or approved method.

5. Replace removed markings at no additional cost to Owner.

END OF SECTION
SECTION 32 31 19

METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes shop fabrication and installation of custom metal fencing, and other metal constructions included in the documents.

B. Related Sections:
   1. Section 03 3000 - Cast-In-Place Concrete: Execution requirements for embedded anchors and attachments for metal fabrications specified by this section in concrete.

1.2 REFERENCES

A. ASTM International:
  13. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
20. ASTM B177 - Standard Guide for Chromium Electroplating on Steel for Engineering Use.
27. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

B. American Welding Society:
1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.
3. AWS D1.6 - Structural Welding Code - Stainless Steel.

C. National Ornamental & Miscellaneous Metals Association:
1. NOMMA Guideline 1 - Joint Finishes.

D. SSPC: The Society for Protective Coatings:
1. SSPC - Steel Structures Painting Manual.
2. SSPC SP 1 - Solvent Cleaning.
3. SSPC SP 10 - Near-White Blast Cleaning.
4. SSPC Paint 15 - Steel Joist Shop Paint.
5. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).

1. PERFORMANCE REQUIREMENTS

A. Delegated Design: Design including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include installation drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

C. Samples: Submit 4”x4” painted steel samples for approval prior to painting and installation.
1.4 QUALITY ASSURANCE
A. Finish joints in accordance with NOMMA Guideline 1.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Section 01 6000 - Product Requirements: Product storage and handling requirements.
B. Accept metal fabrications on site in labeled shipments. Inspect for damage.
C. Protect metal fabrications from damage by exposure to weather.

1.6 FIELD MEASUREMENTS
A. Field verify all measurements prior to shop drawings.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL
A. Steel Sections: ASTM A36/A36M.
B. Steel Plate: ASTM A36/A36M.
C. Hollow Structural Sections: ASTM A500, Grade B.
E. Sheet Steel: ASTM A653/A653M, Grade 33 Structural Quality with galvanized coating.
F. Bolts: ASTM A307; Grade A or B.
   1. Finish: Hot dipped galvanized.
G. Nuts: ASTM A563 heavy hex type.
   1. Finish: Hot dipped galvanized.
H. Washers: ASTM F436; Type 1.
   1. Finish: Hot dipped galvanized.
I. Welding Materials: AWS D1.1; type required for materials being welded.
J. Shop and Touch-Up Primer: SSPC Paint 15, Type 1, red oxide.
K. Welding Materials: AWS D1.6; type required for materials being welded.

2.2 FENCING
A. Fencing design as indicated on Drawings, hot dip galvanized, with polyester powdercoat paint.
2.3 ANCHOR BOLTS

A. Anchor Rods: ASTM F1554; Grade 55, weldable.
   1. Shape: Straight.
   2. Furnish with nut and washer; unfinished.

2.4 FABRICATION

A. Fit and shop assemble items in largest practical sections, for finishing and delivery to site.
B. Fabricate items with joints tightly fitted and secured.
C. Continuously seal joined members by continuous welds.
D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.5 FACTORY APPLIED FINISHES - STEEL

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
B. Do not prime surfaces in direct contact with concrete or where field welding is required.
C. Galvanizing: ASTM A123/A123M; minimum 1.2 oz/sq ft coating thickness; galvanize after fabrication.
D. Galvanizing for Fasteners, Connectors, and Anchors:
   1. Hot-Dipped Galvanizing: ASTM A153/A153M.
   2. Mechanical Galvanizing: ASTM B695; Class 50 minimum.
E. Polyester Powdercoat Finish: Tiger Drylac Series 58 Super Durable or equal. Color: Varies as noted per Materials Schedule and details. Submit one sample of painted metal of each color to landscape architect for selection. Paint thickness is according to manufacturer’s recommendation.
F. Do not prime surfaces in direct contact with concrete or where field welding is required.

2.6 FABRICATION TOLERANCES

A. Squareness: 1/8-inch maximum difference in diagonal measurements.
B. Maximum Offset Between Faces: 1/16 inch.
C. Maximum Misalignment of Adjacent Members: 1/16 inch.
D. Maximum Bow: 1/8 inch in 48 inches.
E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3000 - Administrative Requirements: Coordination and project conditions.
B. Verify field conditions are acceptable and are ready to receive Work.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal and aluminum where site welding is required.
B. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.
B. Make provisions for installation stresses. Install temporary bracing to maintain alignment, until permanent bracing and attachments are installed.
C. Field weld components indicated on Drawings.
D. Perform field welding in accordance with AWS D1.1.
E. Obtain approval of Architect/Engineer prior to site cutting or making adjustments not scheduled.
F. After installation, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

3.4 INSTALLATION TOLERANCES

A. Section 01 4000 - Quality Requirements: Tolerances.
B. Maximum Variation From Plumb: none observable with a spirit level
C. Maximum Offset From Alignment: 1/4 inch / 10'.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Proprietary “off-the-shelf” and custom site furniture per Landscape Materials Schedule and Site Furnishings Plan.

B. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for installing pipe sleeves cast, installing anchor bolts cast and formed voids in concrete footings.
   2. Section 312000 "Earth Moving" for excavation for installing concrete footings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

C. Samples for Verification: For each type of exposed finish, not less than 6-inch- (152-mm-) long linear components and 4-inch- (102-mm-) square sheet components.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings manufactured with preservative-treated wood.

   1. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.
1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bench Replacement Slats and/or Planks: No fewer than two full-size units for each size indicated.
2. Anchors: no fewer than 5 anchors for each anchor type.

PART 2 - PRODUCTS

2.1 PROPRIETARY SITE FURNITURE

A. Products: Subject to compliance with requirements, provide products indicated on Drawings or approved equivalents.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:

1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211 (ASTM B 211M).
3. Structural Pipe and Tube: ASTM B 429/B 429M.
5. Castings: ASTM B 26/B 26M.

B. Steel and Iron: Free of surface blemishes and complying with the following:

1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513/A 513M, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
5. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.

C. Stainless Steel: Free of surface blemishes and complying with the following:

1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
2. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
3. Tubing: ASTM A 554.

D. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.
1. Wood Species: Manufacturer’s standard.
2. Certified Wood: Wood products shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-00 and FSC STD-40-004.
3. Finish: Manufacturer’s recommended transparent wood preservative treatment and sealer shop applied.

E. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer’s standard finish.

F. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
   1. Polyethylene: Fabricated from virgin plastic HDPE resin.
   2. Polyethylene with Recycled Content: Fabricated from HDPE and other resins with postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

G. Anchors, Fasteners, Fittings, and Hardware: Stainless steel; commercial quality, tamperproof, vandal and theft resistant.
   1. Angle Anchors: For inconspicuously bolting legs of site furnishings to on-grade substrate; one per leg or extent as indicated on Drawings.
   2. Antitheft Hold-Down Brackets: For securing site furnishings to substrate; two per unit or as indicated on Drawings.

H. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.

I. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

J. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:
   1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil (0.0076 mm) thick.
   2. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

2.3 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment: Pressure-treat wood according to AWPA U1, Use Category UC3b, and the following:
   1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or
otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.

2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

2.4 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.5 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.7 STEEL AND GALVANIZED-STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with
coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

2.8 IRON FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.9 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   1. Run directional finishes with long dimension of each piece.
   2. Directional Satin Finish: No 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored and/or positioned at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to
comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 32 33 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Piping.
2. Pipe Sleeving.
4. Automatic control valves.
5. Automatic drain valves.
6. Connection to Water Supply
7. Sprinklers.
8. Quick couplers.
9. Drip irrigation specialties.
10. Controllers.

B. Related Sections:

1. Section 329113 “Soil Preparation” for planting bed and rain garden soil preparations.
2. Section 329200 “Turf and Grasses” for sodding/seeding (lawn).
3. Section 329300 “Plants” for planting.

1.3 DEFINITIONS

A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

C. ET Controllers: EvapoTranspiration Controllers. Irrigation controllers which use some method of weather based adjustment of irrigation. These adjusting methods include use of historical monthly averages of ET; broadcasting of ET measurements; or use of on-site sensors to track ET.

D. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
1.4 SCOPE OF WORK

A. Furnish all design, labor, materials, and equipment for the proper installation of an irrigation system to service all lawn and planting areas. Maintain 100 percent water coverage of planting areas indicated.

B. ALL LANDSCAPE AREAS SHOWN ON THE LANDSCAPE PLAN ARE TO BE IRRIGATED (UNLESS NOTED OTHERWISE).

C. Unless noted otherwise, shrub and perennials/ornamental grasses shall be irrigated via drip irrigation. Rain sensors and smart controllers shall be included within the irrigation system.

D. Weather or soil moisture sensors, drip or low volume irrigation, high-efficiency spray nozzles, and pressure regulated and check-valve sprinkler bodies must be incorporated as required in new components. Individual sub-zones must be tailored to the watering requirements of each major plant type, and sun/shade exposures and existing terrain shall also be considered when zoning the system. Under no circumstances shall any turf areas be watered in combination with plant beds. Spacing of all sprinkler equipment selected shall never exceed the manufacturer's recommendations as published.

E. “Head to head” coverage is required in all turf areas. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards.

F. If an irrigation system exists, the contractor is to verify existing system and provide modifications to the existing system to accommodate the new landscape design. Retain existing controller if possible.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Irrigation Design Drawing:
   1. Irrigation design to be prepared and drawn by the irrigation contractor in the form of an “Irrigation Design Drawing”. The irrigation design drawing shall be submitted in an electronic format. Submit design drawings for approval at least 2 weeks prior to the commencement of any work.
   2. The owner’s representative and landscape architect may accept the irrigation design drawing as submitted; may mark-up minor corrections, and accept the irrigation design drawing as marked-up; or may reject the irrigation design drawing; and require that it be resubmitted.
   3. All components of the irrigation system shall be shown. Show sprinkler piping, including plan layout and locations, types, sizes, capacities, and flow characteristics of sprinkler piping components. Include water meters, backflow preventers, booster pumps, valves, piping, sprinkler and devices, drains, accessories, controls, and wiring as necessary. All components shall be labeled with the component type, manufacturer, and model, or shall be symbols referenced to a legend or key. All components shall be shown with dimensions to reference points. Show areas of sprinkler spray.
4. Overspray of any paved surfaces, as well as overspray onto any structures in the effort to reduce the number of sprinkler heads is prohibited. Drawing shall be scaled no smaller than 1" = 30'-0". In areas where clarity of the design is in question because of the scale, an enlargement of that area shall be shown so as to provide clarity of the design. Approval of Irrigation Design Drawing shall precede commencement of any work.

5. It is the intent to hid all electrical remote valve boxes from view.

C. Product Data:
   1. Irrigation Contractor shall submit three (3) sets of manufacturer’s technical data to the Owner’s Representative including, but not limited to valves, controller, quick couplers, sprinkler heads, etc.

D. As-Built Drawing:
   1. Irrigation Contractor shall record and submit an “As-Built Drawing” which records actual installed conditions. The As-Built Drawing shall be submitted in an electronic format. Irrigation Contractor shall submit the As-Built Drawing to the Owner's Representative before work under this contract is considered for Final Acceptance.

E. Operations and Maintenance Manuals:

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE
   A. Installer Qualifications: the irrigation system is to be performed and installed by a contractor who specializes in irrigation design and installation and has installed at least 5 projects of equal or comparable size and complexity.

   B. The system shall be designed by a certified EPA WaterSense partner, as found on the EPA WaterSense website, or must be a member of the Irrigation Association (IA) and hold a C.I.D (Certified Irrigation Designer) qualification.

   C. Approval and Selection of Materials and Work: The selection of all materials and the execution of all operations required under this Performance Specification is subject to the approval of the owner’s representative who has the right to reject any and all materials and any and all work which, in their opinion, does not meet the requirements of the contract documents at any stage of the operations. Remove rejected work and or materials from project site and replace promptly.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

   B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

   C. Handle, load, unload, stack and transport materials carefully to avoid damage. Handle pipe in accordance with manufacturer’s recommendations.
1.9 SLEEVING

A. It shall be the Irrigation Contractor’s responsibility to submit the Irrigation Design Drawing, showing these sleeves, in a timely manner, such that the General Construction Contractor is able to install sleeves within an appropriate sequence of work.

B. Irrigation sleeves shall be Schedule 40 PVC, minimum 2X pipe size of proposed irrigation pressure pipe. A separate Schedule 40 PVC sleeve shall be installed for irrigation wire. Ends of all irrigation sleeves shall be marked with 2 x 2 wooden stakes or white pvc pipe. Coordination and scheduling for excavation of sleeve ends is the responsibility of the Irrigation Contractor.

1.10 PROJECT CONDITIONS

A. Prior to commencing any work required under the Contract, the Contractor shall locate all utilities, subsurface drainage, and underground construction so that proper precautions may be taken not to disturb or damage any subsurface improvements. Damage to any of the above mentioned items or other shall be promptly repaired by the contractor at no additional cost to the owner.

B. It is the responsibility of the irrigation contractor to coordinate the location of the irrigation waterline and electrical service.

C. Irrigation System is to operate under the water pressure and flow rates prevailing at the project site. Irrigation Contractor shall be responsible for determining these parameters and shall design the irrigation system in accordance with the existing or anticipated conditions.
   1. In the even water pressure is insufficient to operate the system at an adequate design pressure and flow, the Irrigation Contractor shall be responsible for designing, specifying, supplying, and installing a booster pump capable of increasing the pressure and flow as required. Booster pump shall be operated by either a magnetic starter, flow, or pressure transducer/switch. If a booster pump is required, coordinate provisions of adequate electrical service for the pump with General Contractor.
   2. If the event the water pressure significantly exceeds an appropriate operating pressure, it shall be Irrigation Contractor’s responsibility to provide and install a pressure regulator downstream from the backflow preventer. Pressure regulation may be accomplished via a master valve with a pressure reducing dial or may be accomplished at the individual zone valve locations with a pressure reducing dial.

D. The Irrigation Contractor is responsible for all costs incurred in replacing damaged or stolen materials or equipment prior to Substantial Completion of the Work.

E. Obtain all required permits and pay all required fees at no additional cost to the Owner. Any penalties imposed due to failure to obtain permits or pay fees are the responsibility of the Irrigation Contractor.

F. Existing Site Improvements: Perform Work in a manner that avoids damage to existing site improvements. The Irrigation Contractor is responsible for any damage of mechanical nature as well as damage resulting from leaks in the irrigation system whether due to negligence or otherwise.
1.11 SEQUENCING AND SCHEDULING

A. Coordinate modifications and installation of irrigation as shown on the Contract Drawings with all other work.

B. Coordinate layout and installation of irrigation sleeves, conduits and piping under paved areas and other site features prior to their construction.

C. Coordinate installation of irrigation system with excavation of planting beds and backfilling of planting beds with topsoil.

D. Coordinate layout and installation of irrigation system with location and installation of plant material to ensure that there will be complete and full irrigation coverage of planting.

E. Trees shall be located and planted prior to the installation of the irrigation system.

1.12 WARRANTY

A. Warranty all Work for a period of one (1) year, starting on the Date of Substantial Completion, against defects in materials, equipment, workmanship, and any repairs required resulting from leaks or other defects of workmanship, material or equipment.

1. Make repairs and replacements and guarantee the satisfactory operation of the entire system in every detail for the 1 year Warranty Period. All warranty repairs and replacements are part of the Contract.

2. Irrigation Contractor to provide 1st year winterization and following year Spring opening.

3. Thirty days prior to completion of the plant Warranty Period, the Contractor shall provide a course on the use, adjustment, and maintenance of the automatic controller and irrigation heads. The instructions shall include an on-Site review/walk through of the irrigation system(s) as well as an office session to review the O&M Manual documentation. If the Warranty Period ends during the freezing season, schedule the training within 10 days of the Final Inspection after reactivation of the irrigation system.

4. Provide Special Tools and Spare Parts:
   a. 4 percent additional sprinklers and nozzles of each type and spray pattern.
   b. 2 wrenches for disassembly and adjustment of each type of sprinkler head installed.
   c. 2 keys for each automatic controller.
   d. 1 valve box cover key for each 10 valve boxes.
   e. Backflow device valve handles.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products from one of the following manufacturers:

1. Hunter Industries, Inc.
2. The Toro Company
3. Rain Bird Sales, Inc.
2.2 GENERAL

A. Quality and Size
   1. All materials used in the system must be new and without flaws or defects of any type and be the best quality available, and compatible with existing system. All sprays, rotors and valves shall have a minimum three (3) year warranty against material defects or defective workmanship.

2.3 PIPES

A. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedules 40 and 80.
   1. PE Controlled OD Pipe: ASTM F 771 and ASTM D 3035, PE 3408 compound, DRs 9 and 11.
   2. PE Controlled ID Pipe: ASTM F 771 and ASTM D 2239; PE 3408 compound; SIDRs 7, 9, 11.5, and 15.

B. PIPE AND TUBE FITTINGS
   1. PVC Socket Fittings, Schedule 40: ASTM D 2466.
   2. Insert Fittings for PE pipe: ASTM D 2609, NP or PP. Include bands or other fasteners.

2.4 SPRINKLERS

A. Fixed Spray Sprinkler Head: Manufacturer's standard sprinklers designed for uniform coverage over entire spray area indicated, at available water pressure. Pop-up spray sprinkler shall be of the fixed spray type designed for in-ground installation. Sprinklers shall include a pressure regulating device to prevent high pressure fogging to the nozzle stream.

B. Spray nozzles: High-efficiency nozzles with a distribution uniformity (DULQ) of 70% or greater shall be used. The higher efficiency nozzle should result in better than a 1.2 SC, reducing runtime accordingly.

C. Intermediate Turf Rotors: Sprinkler shall be a single stream, water lubricated, gear drive type capable of covering the areas between 25 and 35 feet at a minimum base pressure of 45 psi. The part circle sprinkler shall have adjustable arc coverage of 40 to 360 degrees. The sprinkler shall have a standard rubber cover, tapered stem for positive flushing and a strong stainless steel retract spring for positive pop down.

D. Long Range Rotors: The full or part circle sprinkler shall be a single stream, water lubricated, gear drive type. The sprinkler shall have a rotating nozzle turret independent of the riser stem. Sprinkler shall be full and part circle operation in a single unit, and when adjusted to the full circle position shall rotate in a single continuous direction.

E. Components: Corrosion-resistant interior parts.

F. Flush, surface sprinklers: Fixed pattern, with screw type flow adjustment.

G. Bubblers: Fixed pattern with screw type flow adjustment

H. Shrubbery Sprinklers: Fixed pattern, with screw type flow adjustment

I. Pop-up, Rotary, Spray Sprinklers: Gear drive, full circle and adjustable part-circle types.
2.5 VALVES AND VALVE SPECIALTIES

A. Automatic remote control valves shall operate each zone and shall be sized as per manufacture’s recommendations. Valves shall be housed in a valve box with cover marked with zone number. Valves shall be capable of being run manually.

B. Control-Valve Boxes: PE, fiberglass, polymer concrete, or precast concrete box and cover, with open bottom, openings for piping, and designed for installing flush with grade. Include size as required for valve and service.
   1. Drainage backfill: Cleaned gravel or crushed stone, graded from 3 inches maximum to ¾ inch minimum.

2.6 RAIN SENSORS

A. Automatic Rain Shut-off Device. Rain sensor shall employ an electro-mechanical actuating mechanism designed to cause a circuit interrupt if programmable rainfall set points are satisfied.

B. The wireless rain sensor shall incorporate a provision that allows the installer to select from several rainfall settings that can be programmed through the use of icons on a controller interface.

2.7 AUTOMATIC CONTROL SYSTEM

A. Controller Stations for Automatic Control Valves: Irrigation controller shall have a modular station capacity. The controller shall be a hybrid type, housed in a wall-mountable, weather resistant plastic cabinet with a key-locking cabinet.

B. Timing Device: Adjustable, 24-hour, 14-day clock with automatic operations to skip operation any day in timer period; to operate every other day; or to operate two or more times daily.

C. Wiring: UL 493, Type UF, solid-copper-conductor, insulated CAE, suitable for direct burial.

2.8 QUICK COUPLERS

A. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.

2.9 DRIP IRRIGATION SPECIALTIES

A. Freestanding Emitters: Device to deliver water at approximately 20 psig.
   1. Body Material: PE or vinyl, with flow control.

B. Manifold Emitter Systems: Manifold with tubing and emitters.
   1. Manifold: With multiple outlets to deliver water to emitters.
b. Outlet Caps: Plastic, for outlets without installed tubing.
c. Operation: Automatic pressure compensating.

2. Tubing: PE or PVC; 1/8-inch minimum ID.
3. Emitter: Device to deliver water at approximately 20 psig.
   a. Body Material: PE or vinyl, with flow control.

C. Multiple-Outlet Emitter Systems: Emitter with tubing and button-type outlets.
   1. Emitter: With multiple outlets to deliver water to remote outlets.
      b. Outlet Caps: Plastic, for outlets without installed tubing.
      c. Operation: Automatic pressure compensating.
      d. Emitters: Devices to deliver water at approximately 20 psig

PART 3 - EXECUTION

3.1 GENERAL
A. Supervision: Provide a full-time superintendent and necessary assistants on the job while Work is in progress. Irrigation contracting firm shall have a C.I.C. (certified irrigation contractor) on site at all times and must be an employee of said irrigation contracting company. The Superintendent represents the Irrigation Contractor in all functions, and directives given to him by the Owner’s Representative, Landscape Architect, General Construction Contractor, and / or Landscape Contractor are binding as if given to the Irrigation Contractor in person.

B. Inspection of Work in progress: During installation the Owner’s Representative or the Landscape Architect may review and observe the Work on a regular or random basis, and may reject any work and / or materials that do not meet the requirements of the Contract Documents. Rejected Work must be promptly corrected. No time extension will be allowed replacement or repair of rejected work.

3.2 REVIEW IN ADVANCE OF CONSTRUCTION
A. The Irrigation Contractor shall review the Project Site prior to start of Work to determine that all site conditions are acceptable for Irrigation Work to begin. Inform the Owner’s Representative and the Landscape Architect of any and all unsuitable conditions. Do not proceed with installation of irrigation system until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 PREPARATION
A. Flag all existing underground utilities prior to trenching and / or boring operations. Obtain locations of any new utilities from the Owner’s Representative and / or the General Contractor. Irrigation Contractor is solely responsible for contacting the utility locating service(s) and Owner’s Representative (with 48 hours minimum notification) and locating on - site utilities in advance of installation.
3.4 SLEEVING

A. Location of sleeving shall be coordinated with the General Construction Contractor. Make adjustments necessary to accommodate existing vegetation, utilities, and other existing conditions.

B. Repair of damage to existing utilities, structures or other construction resulting from installation of sleeves is the responsibility of the Contractor installing the sleeving.

3.5 TRENCHING

A. All mainline to be installed in separate trenching process from lateral lines.

B. During the entire prosecution of the work, the Contractor will be responsible for all open excavations and as a means of protection, shall keep such protective devices buried at proper intervals along the excavation to protect the public from injury.

C. Trenching and excavation in established grass or newly seeded areas: After trenching, excavation and backfilling is completed, re-grade trenched area consistent with surrounding area and reseed with turf seed matching existing grass or seed. Mulch seed after broadcasting.

D. Trenching and excavation through existing asphalt or concrete: Cutting, removal and replacement of asphalt or concrete is the responsibility of the Irrigation Contractor.

E. Trenching and excavation near existing trees: Irrigation Contractor shall paint the proposed trenching or excavation which occurs within the “drip line” or within fifty (50) feet of the trunks of the existing trees (8” caliper or larger). Irrigation Contractor must contact the Owner’s Representative for review of the proposed trenching and excavation lines prior to proceeding with the work. Owner’s Representative may adjust proposed trenching and excavation lines in order to avoid damage to tree root systems and other plants. Such adjustments shall be made by the Irrigation Contractor at no additional cost to the Owner.

F. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.

G. Provide minimum cover over top of underground piping according to the following:

1. Minimum depth of cover of pipe is as follows:
   a. One – half (1/2) to one (1) inch: Twelve inches
   b. One and one – quarter (1 ¼) to two (2) inch: Fifteen inches
   c. 3 & 4 inch: Twenty-four inches.

3.6 PIPING INSTALLATION

A. Pipe joints

1. Follow manufacturer's recommendations and use pipe and bell from the same manufacturer. Pipes two and one - half (2 1/2) inches and smaller use solvent weld system. Pipes three (3) inches and larger use approved compression type push on joints.

B. Solvent weld PVC Pipe, assemble according to Manufacturer's recommendations, using appropriate PVC pipe cleaner/primer and solvent cement.
C. Pipes and Fittings
1. Install according to Manufacturer’s recommendations including snaking in of PVC pipe to prevent excessive strain when contracting in cold weather.
2. Solvent weld fittings shall conform to Schedule 40 or Schedule 80 PVC dimensions and specifications for solvent weld fittings.

D. Lateral Lines and Risers
1. Install according to Manufacturer’s recommendations using standard techniques.
2. Install risers such that no excessive movement occurs while sprinkler head is in operation. Height of risers to be in accordance with planned and existing plant material. Height of all risers is subject to approval of Landscape Architect.
3. Plug lines immediately upon installation to minimize infiltration of foreign matter.
4. Flush lateral lines and risers prior to installation of sprinkler heads.

3.7 VALVE BOXES
A. All valves are to be housed in valve boxes. Install according to Manufacturer’s recommendations. Position boxes at a height where they will not interfere with maintenance machinery (e.g., mowers) and such that soil and mulch do not wash into the box.

3.8 SPRINKLER HEADS
A. Sprinklers with a 1” and larger bottom inlet shall be installed on swing joints, minimum 3” off inside edge of curbs, drives and sidewalks. Sprinkler with a 3/4” and smaller inlet may be installed using flexible swing joints.
B. Low Pop-up Sprinkler Heads: Install in such manner that top is flush with finish grade. Where finish grade has not been established extend riser a minimum of twelve (12) inches above existing grade to mark location of head. After finish grade is established install heads at specified height.
C. High Pop-up Shrub Heads: Finish height to be proposed by Irrigation Contractor as a function of plants specified on landscape plans and noted on irrigation design submittal.
D. Backfill around sprinkler head assembly in such manner as to stabilize the sprinkler head so that no lateral motion occurs during operation.
E. Sprinkler heads on risers: Utilize a schedule 80 T.O.E. nipple. If greater than 24” height is required, provide fitting in the ground with a solvent weld 90 degree elbow with the appropriate length of pipe glued to it and coming out of the ground to the desired height. Glue male adapter to the riser to allow for the connection of the sprinkler head. Stabilize riser by fastening it to rebar as required. Height of all heads in bed areas to be proposed by Irrigation Contractor as a function of plants specified on landscape plans.
F. Landscape Drip Line shall be located in a manner that will provide optimum concentration of water to plant material.

3.9 DRIP IRRIGATION INSTALLATION
A. Install freestanding emitters on pipe riser to mounting height indicated.
B. Install manifold emitter systems with tubing to emitters. Plug unused manifold outlets. Install emitters on off-ground supports at height indicated.

C. Install multiple-outlet emitter systems with tubing to outlets. Plug unused emitter outlets. Install outlets on off-ground supports at height indicated.

D. Install drip tubes with direct-attached emitters on ground.

E. Install drip tubes with remote-discharge on ground with outlets on off-ground supports at height indicated.

F. Install off-ground supports of length required for indicated mounted height of device.

3.10 BACKFLOW PREVENTER

A. Installation in accordance with manufacturer's recommendations and all federal, state and local codes.

3.11 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

A. Equipment Mounting: Install interior controllers on wall.

B. Install control cable in same trench as irrigation piping and at least 2 inches below or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

3.12 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Any irrigation product will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.
3.13 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that controllers are installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal.
4. Avoid overwatering during the establishment period. Too often, the plantings are overwatered while the sod becomes established (typically 2 weeks after installation). Once the sod is established cut back the irrigation water times and frequency.

3.14 ADJUSTING

A. Adjust settings of controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch above, finish grade.

3.15 CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

3.16 WINTERIZING SYSTEM

A. For the first winter season, the irrigation contractor is to winterize the irrigation piping by blowing the system clear of water using compressed air (eighty (80) psi maximum) admitted into the piping at a quick coupling valve or hose bib located at a higher elevation on the system piping. Activate individual zones, higher zones first, then proceed successively through the system towards lower elevations. Proceed through all zones twice. The air compressor used to winterize the system must have an engine separate from the compressor tanks to prevent high temperature air from being injected directly into the PVC piping.

B. Irrigation Contractor shall provide a complete spring start up at no additional charge. Owner's maintenance staff must be present at the time of the winterizing and spring start up.

3.17 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

3.18 INSPECTION AND ACCEPTANCE

A. Upon completion of Work, the Contractor shall notify the Owner's Representative and the Landscape Architect at least ten (10) days prior to requested date of review for Substantial Completion of all portions of the work. Landscape Architect will issue a punch list for work to be corrected. All work on the punch list must be completed within ten (10) working days from the
date of inspection. Where Irrigation Work does not comply with requirements, replace rejected Work. In unusual circumstances a longer time period may be granted by the Owner's Representative. If such replacements are not completed within the time specified, the Irrigation Contractor may be considered to be in default of the Contract, and the Owner's Representative may use the contract retainage to hire other Contractors to finish the Work.

B. It will be the responsibility of the Irrigation Contractor to provide a reliable communication system (i.e., two way radios or remote radio control activation system) for Substantial Completion and Final Inspections.

C. If an inspection / acceptance walk-thru has been scheduled and the Landscape Architect arrives at the site and determines that the Irrigation System is not substantially complete (all system components in place, operational, and checked with 100% sprinkler coverage), the Irrigation Contractor shall be responsible for all costs incurred by the Landscape Architect to revisit the site at a future date. Reimbursable expenses include, but are not limited to, automobile mileage, airfare, landscape architect's hourly billing rate, parking fee, meals, rental car, etc. All incurred expenses will be deducted from the final contract amount or the contract retainage.

D. Certificate of Substantial Completion will be issued for satisfactory completion of repairs and replacements and completion of As-Built Drawings. If punch list items are issued with the Certificate, they must be corrected within ten (10) working days.

E. Final Acceptance: Two years after Date of Substantial Completion of the Work, the Owner's Representative will review the Work for Final Acceptance. The Final Acceptance Certification issued by the Owner's Representative/Landscape Architect will serve as evidence that Contractor's two (2) year warranty obligations have been met.

END OF SECTION 32 84 00
SECTION 32 91 13
SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Planting Soils
   2. Planting Soils Testing
   3. Planting Soil Preparation

B. Related Requirements:
   1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
   2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
   3. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS


B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.


M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.


1.4 QUALITY ASSURANCE

A. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State of Minnesota, Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

   1. Soil Analysis

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; soluble salts; deleterious material; pH; and mineral and plant-nutrient content of the soil.

   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

   2. Depth, location, and number of samples to be taken per instructions from Landscape Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.


   a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

   b. Test for presence of soluble salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include recommendations for application and use.
   2. Include test data substantiating that products comply with requirements.
   3. Include sieve analyses for aggregate materials.
   4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
      a. Manufacturer's qualified testing agency's certified analysis of standard products.
      b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
      c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Samples: For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.8 TESTING AGENCY QUALIFICATIONS

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing on-site soil.
   1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.10 SOIL-SAMPLING REQUIREMENTS

A. Sample Collection and Labeling: Have samples taken and labeled by Contractor under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.11 TESTING REQUIREMENTS

A. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."

   a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."

B. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

C. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13, including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.


E. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inchdepth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inchdepth of soil.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
PART 2 - PRODUCTS

2.1 PLANTING SOILS

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory’s recommendations after preconstruction soil analyses are performed.

B. EXISTING ON-SITE PLANTING SOIL: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil:

1. Sources: Unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.

2. Unacceptable Properties: Clean soil of the following:

   a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

   b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.

   c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 6” in any dimension.

3. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers (PER TESTING RESULTS) in the following quantities to produce planting soil:

   a. Compost.
   b. Sphagnum
   c. Lime.
   d. Sulfur/Iron Sulfate.
   e. Agricultural Gypsum.
   f. Superphosphate.
   g. Commercial Fertilizer.
   h. Slow-Release Fertilizer.

A. IMPORTED PLANTING SOIL: Shall be natural, friable, fertile, fine, sandy loam possessing the characteristics of representative topsoil in the vicinity which produce heavy growths of vegetation. The topsoil shall be free from subsoil, clay lumps, clods, weeds, brush, tree roots, branches, stones larger than 1-inch in any dimension, lime, concrete, ashes, slag, or other deleterious matter and shall be well drained in its original conditions and free of toxic quantities of acid or alkaline elements.

1. Planting soil for perennial beds and tree/shrub backfill shall conform to MNDOT Spec 3877.2B (Table 3877-2). “Loam Topsoil Borrow”. Contractor shall be responsible for hauling, mixing and placement.

2. Planting soil for turf areas shall conform to MNDOT Spec 3877.2A (Table 3877-1), “Common Topsoil Borrow”. Contractor shall be responsible for hauling, mixing and placement.

3. Unacceptable Properties: Manufactured soil shall not contain the following:
a. **Unacceptable Materials:** Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

b. **Unsuitable Materials:** Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.

c. **Large Materials:** Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches in any dimension.

### 2.2 INORGANIC SOIL AMENDMENTS

A. **Lime:** ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. **Class:** O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
   2. **Form:** Provide lime in form of ground dolomitic limestone.

B. **Sulfur:** Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. **Iron Sulfate:** Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. **Aluminum Sulfate:** Commercial grade, unadulterated.

E. **Perlite:** Horticultural perlite, soil amendment grade.

F. **Agricultural Gypsum:** Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

G. **Sand:** Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

### 2.3 ORGANIC SOIL AMENDMENTS

A. **Compost:** Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. **Feedstock:** Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source separated or compostable mixed solid waste.
   2. **Organic-Matter Content:** 30 to 60 percent of dry weight.

B. **Manure:** Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

### 2.4 FERTILIZERS

A. **Bonemeal:** Commercial, phosphate mixture, soluble; a minimum of 4 percent nitrogen.
B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.
   1. Install minimum 6" planting soils to amend existing soils in all perennial planting beds, and tree and shrub planting areas.
   2. Install minimum of 4" topsoil in areas to receive sod / turf seeding.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth as required to allow installed soil depths specified by plant material.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 6 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 6 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
   a. Mix lime and sulfur as required with dry soil before mixing fertilizer.
   b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Use air spade to prepare soil in planting areas located within dripline of trees to preserve root zones.

C. Mixing: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
   1. Mix lime and sulfur with dry soil before mixing fertilizer.
   2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix 4 inches of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform the following tests and inspections:
   1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
C. Soil will be considered defective if it does not pass tests and inspections.

3.7 PROTECTION AND CLEANING
A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Vehicle traffic.
   4. Foot traffic.
   5. Erection of sheds or structures.
   6. Impoundment of water.
   7. Excavation or other digging unless otherwise indicated.
B. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Landscape Architect and replace contaminated planting soil with new planting soil.

3.8 CLEANING
A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
   1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 32 91 13
SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Turf Sodding.
   2. Turf renovation.

B. Related Requirements:
   1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 “Soil Preparation” and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 REFERENCED STANDARDS


   1. Labeling Sections 201.8 to 201.31.
1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. If needed, insert list of conference participants not mentioned in Section 013100 "Project Management and Coordination."

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor and personnel assigned to the Work shall have certification in all of the following categories from the Professional Landcare Network:

   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Lawncare Manager.
   c. Landscape Industry Certified Lawncare Technician.

5. Pesticide Applicator: State licensed, commercial.
1.9 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk materials with appropriate certificates.

1.10 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: Ground thaw to June 15th.
   2. Fall Planting (Sodding): August 15 to November 1.
   3. Fall Planting (Seeding): August 15 to September 15.
   4. Summer planting may be allowed if site irrigation is included within the project. Obtain landscape architect approval if planting outside of the dates listed above.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 TURFGRASS SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:
   1. Quality: State-certified seed of grass species as listed below for solar exposure.
   2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
   3. Sun and Partial Sun: Proportioned by weight as follows:
a. 50 percent Kentucky Bluegrass (Poa pratensis).
b. 30 percent Chewings Red Fescue (Festuca rubra variety).
c. 10 percent Perennial Ryegrass (Lolium perenne).
d. 10 percent Redtop (Agrostis alba).

4. Shade: Proportioned by weight as follows:
   a. 30 percent Hard Fescue (Festuca brevipilia).
   b. 30 percent Perennial Ryegrass (Lolium perenne).
   c. 20 percent Chewings Red Fescue (Festuca rubra variety).
   d. 20 percent Kentucky Bluegrass (Poa pratensis).

C. Grass-Seed Mix: Proprietary seed mix as follows:

   1. Products: Subject to compliance with requirements, provide the following:
      a. TRUE SEED AND SUPPLY – 612-670-4590

2.2 TURFGRASS SOD

   A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

   B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

      1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
         a. ‘Highland’ – salt tolerant variety.
         b. ‘Salty’ – salt tolerant variety.
         c. MNST-12 Sod seed mixtures.

2.3 FERTILIZERS

   A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

      1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

   B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

      1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.4 MULCHES

   A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a natural cotton mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

1. Reduce elevation of planting soil to allow for soil thickness of sod.

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 4 to 6 lb/1000 sq. ft. Or supplier’s recommendations if different.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer’s written instructions.

E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer, slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre
dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.7 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 PLUGGING

A. Plant plugs in holes or furrows, spaced per plan/specifications apart in random pattern.

3.9 TURF RENOVATION

A. Renovate existing turf where indicated.

B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch or sod as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.10 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow Kentucky bluegrass to a height of 1-1/2 to 2 inches.

D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.11 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.14 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion.
   a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: 30 days from date of Substantial Completion.

END OF SECTION 32 92 00
SECTION 32 93 00
EXTERIOR PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Plants.
   2. Landscape edging
   3. Tree Stabilization
   4. Organic Mulch
   5. Planting Soil
   6. Topsoil
   7. Landscape Boulders

B. Related Requirements:
   1. Section 329200 "Turf and Grasses" for turf (lawn).
   2. Section 024101 "Tree Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Finish Grade: Elevation of finished surface of planting soil.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and mollusccicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.


2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale
rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of two photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Trees and Shrubs: Two physical samples of each variety and size delivered to site for review.
2. Compost Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
3. Mineral Mulch: 2 lb of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on-site; provide an accurate indication of color, texture, and makeup of the material.
4. Weed Control Barrier: 12 by 12 inches.
5. Landscape Boulders: Provide images for approval prior to delivery
6. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Interior.
   c. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball.

F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

G. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

H. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
   1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
   2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
   3. Do not remove container-grown stock from containers before time of planting.
   4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Deciduous B&B and Potted Plants:
      a. April 15th to June 15th.
      b. August 21 to November 15th.
   2. Coniferous Evergreen B&B:
      a. April 15 to June 15th.
      b. August 21 to September 30.
   3. Summer plantings may be allowed if site irrigation is included within the project. Obtain landscape architect approval if planting outside of the dates listed above.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   b. Structural failures including plantings falling or blowing over.
   c. Faulty performance of tree stabilization edgings.
   d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.
   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
   b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk (“included bark”); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including

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genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

F. Annuals: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: As recommended by manufacturer.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.
2. Size Range: 2 inches maximum, 1/2 inch minimum.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Mineral Mulch: Hard, durable stone of the following type, size range, and color:

1. Type: Granite
2. Size Range: 3/8 inches minus
3. Color: St. Cloud gray

2.4 LANDSCAPE BOULDERS

A. (2) Rounded glacial boulders per Materials Schedule, set securely in grade.

2.5 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position.
Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd.

2.6 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.7 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring 8 inches in diameter and 48 inches long, treated with specified wood pressure-preservative treatment.
3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
4. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter for large trees / 0.080 inch in diameter for small trees.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
8. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and according to manufacturer's written recommendations.

B. Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated; stakes pointed at one end.
3. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized according to manufacturer's written recommendations unless otherwise indicated.

2.8 LANDSCAPE EDGINGS

A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Collier Metal Specialties, Inc.
   c. J. D. Russell Company (The).
   d. Sure-loc Edging Corporation.

2. Edging Size: 3/16 inch thick by 4 inches deep.
3. Stakes: Tapered steel, a minimum of 12 inches long.
5. Finish: Manufacturer's standard paint.
   a. Paint Color: Black.

2.9 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Burlap: Non-synthetic, biodegradable.

C. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

D. Planter Filter Fabric: Woven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

E. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
   3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect’s acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Before planting, obtain Architect’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

C. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer’s written recommendations.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Percolation Test: One test location per 20 trees. Prior to testing, submit site plan with proposed test locations marked for approval by Landscape Architect. Additional tests may be needed as required by Landscape Architect. Mark testing locations with visible stake.

   a. Fill planting hole with water and allow it to drain completely.
   b. Hardpan Layer: Drill 6-inch diameter holes, 24 inches apart, into Hardpan Layer
   c. Fill planting hole with water again and immediately measure the depth of the water in the pit with a ruler. Record the time.
   d. After 15 minutes have passed, measure the depth of the water in the pit again.
   e. Multiply the number of inches that have drained by 4 to get drainage in inches per hour.
   f. Drainage will fall into one of three categories:
      1. Poorly drained = less than 2” per hour
      2. Well drained = 3” to 6” per hour
      3. Excessively drained = more than 6” per hour
   g. Prepare written test results and submit to Landscape Architect. If soils are poorly drained, immediately notify Landscape Architect of this condition. Upon direction, contractor shall complete soil decompaction procedure per of this Section, and/or install 6” perforated pvc drain tile encased in granular material, wrapped in geotextile and connect to nearest storm sewer line.

B. Planting Pits and Trenches: Excavate circular planting pits.

   1. Excavate planting pits according to planting details and with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom
leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

2. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected after working hours.
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

C. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

D. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

E. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
   a. Quantity: Per manufacturer recommendations.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
   a. Quantity: Per manufacturer’s recommendations.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 1 inch above adjacent finish grade.

2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside soil-covered roots about 1 inch from root tips; do not place tablets in bottom of the hole or touching the roots.
   a. Quantity: Per manufacturer recommendations.


F. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

A. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.
C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 3-inch through 5-inch caliper. Stake trees of less than 3-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated.

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

   a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle for each guy wire and tighten securely.

   b. For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle for each guy wire and tighten securely.

   c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.

   d. Support trees with guy cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.

   e. Attach flags to each guy wire, 30 inches above finish grade.
2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball on slopes unless otherwise indicated.

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.

   a. Install stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation. Saw stakes off at horizontal stake.

   b. Install screws through horizontal hold-down and penetrating at least 1 inch into stakes. Predrill holes if necessary to prevent splitting wood.

   c. Install second set of stakes on other side of root trunk for larger trees.

2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.9 ROOT-BARRIER INSTALLATION

A. Install root barrier where trees are planted within 60 inches of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.

B. Align root barrier vertically, and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.

C. Install root barrier continuously for a distance of 60 inches in each direction from the tree trunk, for a total distance of 10 feet per tree. If trees are spaced closer, use a single continuous piece of root barrier.

   1. Position top of root barrier according to manufacturer's written recommendations.

   2. Overlap root barrier a minimum of 12 inches at joints.

   3. Do not distort or bend root barrier during construction activities.

   4. Do not install root barrier surrounding the root ball of tree.

3.10 PLACING SOIL IN PLANTERS

A. Place a layer of drainage gravel at least 4 inches thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 6 inches up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.

B. Fill planter with planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches below top of planter, allowing natural settlement.

3.11 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.12 PLANTING AREA MULCHING

A. For shrub plantings, install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 12 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

2. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of mineral mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.13 EDGING INSTALLATION

A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

3.14 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.15 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.16 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.17 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
   1. Submit details of proposed pruning and repairs.
   2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
   3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
   1. Provide new trees, shrub or perennial of same size as those being replaced.
   2. Species of Replacement Trees: Species selected by Architect.

3.18 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.
3.19 MAINTENANCE

A. Maintenance Service for Trees, Shrubs and Perennials: Provide maintenance by skilled employees of landscape Installer. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

END OF SECTION 32 93 00
SECTION 33 3000
SANITARY SEWERAGE UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Site sanitary sewer pipe construction to extent as shown on the drawings. Municipal sanitary drains; including fittings, accessories and bedding.
C. Sanitary drainage piping;
   1. Polyvinyl Chloride (PVC) pipe.
      a. SDR 26
   2. Building services.

1.02 RELATED SECTIONS
A. Section 02 4113 - Selective Site Demolition.
B. Section 31 2333 - Trenching and Backfilling.
C. Section 33 4000 - Storm Drainage Utilities.

1.03 REFERENCES
E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.

1.04 QUALITY ASSURANCE
A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.
B. Conform to all applicable code for materials and installation of the Work of this Section.
C. Verify that survey bench mark and intended elevations for the Work are as indicated.
D. The Contractor is responsible for coordinating construction schedule and required testing with testing agency prior to start of construction.

E. Submit documents under the provisions of Division One Specifications.

F. Record location of pipe sizes, materials and runs, connections, manholes, cleanouts and invert elevations.

G. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

H. The Contractor is to employ the services of a Registered Land Surveyor to perform the specified layout work.

I. Record Drawings:

1. Refer to "Submittals" and "Field Quality Control" of this Section.

1.05 FIELD MEASUREMENTS

A. Verify actual locations of sanitary sewage systems with other construction to which sewage systems must fit by accurate field measurements before installation. Coordinate installation schedule with construction progress to avoid delay of the Work. No additional compensation will be given for problems resulting from the Contractor's failure to verify and/or coordinate sanitary sewer work.

1.06 SUBMITTALS

A. Submit under provisions of Division One Specifications.

B. Shop Drawings: The Contractor shall submit a Shop Drawing portfolio showing all piping, fittings, manholes, covers, etc., provided under this section prior to construction.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

D. Project Record Drawings: The Contractor shall mark, in red pencil or ink, field changed made in the Contract Drawings. One set of clean prints shall be used for this purpose. This set of prints shall not be used for construction purposes and shall be kept as clean as possible.

1. The record drawing shall be submitted after the date of Substantial Completion, prior to project closeout, and prior to the release of retainage Architect/Engineer.

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.07 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this section.

1. Minnesota Department of Labor and Industry.

2. Local Codes and Ordinances.

3. Local Authority having Jurisdiction.
1.08 COORDINATION
A. Prior to construction and start of building plumbing, the Contractor shall coordinate all work with the Building Mechanical Contractor and any public agency where connections are to be made. The Contractor is to verify all pipe sizes, material and invert elevations at connections. No additional compensation will be allowed for work not verified or not coordinated.

1.09 PROJECT CONDITIONS
A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.
B. Protection of Persons: The Owner's activities will continue about the site during construction. Install barricade fencing, as necessary, to provide a safe environment between construction work and pedestrian circulation.
C. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer's satisfaction and at no cost to the Owner.
D. Existing Utilities:
   1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.
   2. The approximate locations of certain underground lines and structures are shown on the plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.
   3. Locate and mark these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.
   4. Locate, excavate, and expose all existing underground lines in advance of trenching operations.
   5. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.
E. Traffic Control:
   1. Maintain vehicular and pedestrian traffic as required for construction activities.
   2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of the Work.
   3. When working in public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.
1.10 CONFLICTING UTILITIES
A. When alterations to existing utilities are shown to avoid conflicts, make alterations at no cost to the Owner.

1.11 DELIVERY, STORAGE AND HANDLING
A. Deliver, store, handle and protect products to the site under the provisions of Division One Specifications.

1.12 WARRANTY
A. Provide one (1) year warranty. Warranty shall be in addition to, and run concurrent with, other warranties required by the Contract Documents, including the Division One Specifications. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under the requirements of the Contract Documents.
B. Warranty: State that all materials and workmanship provided are guaranteed against defects after completion and final acceptance of the Work. Defects due to faulty materials or workmanship developed during the guarantee period shall be satisfactorily repaired or replaced by the Contractor at their expense.

PART 2 PRODUCTS

2.01 PIPE AND MATERIAL
A. General:

1. Materials required for this Work shall be new materials conforming to the requirements of the referenced Specification for the class, kind, type, size, grade and other details indicated on the drawings.

2. Wherever connection of dissimilar materials or design is required, the method of joining and any special fittings employed shall be subject to approval by the Architect/Engineer.

3. The Drawings indicate various lengths of sanitary sewer. These dimensions are from center of structure to center of structure. The Contractor is to verify the pipe lengths prior to bidding.

B. PVC Pipe (SDR 26): Pipe and fittings shall conform to the requirements of ASTM D3034, Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings, SDR 26. The grade used shall be resistant to aggressive soils or corrosive substances in accordance with the requirements of ASTM D543.

1. Unless otherwise specified, all pipe and fittings shall be SDR 26 and connections shall be push-on with "O" ring elastomeric gasketed joints conforming to the requirements of ASTM F477, which are bonded to the inner wall of the gasket recess of the bell socket.

PART 3 EXECUTION

3.01 EXAMINATION
A. Examine the areas and conditions under which the Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.
3.02 LAYING OUT WORK
A. Provide all materials, labor, instruments, etc. required to lay out the Work.
B. The Contractor is to employ the services of a Registered Land Surveyor to perform specified layout work.
C. Promptly inform the Architect/Engineer of discrepancies found, in order that proper corrections may be made.

3.03 BEDDING
A. Install and bed PVC pipe in accordance with ASTM D2321, Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe. Embedment materials shall be Class I or Class II. These materials shall pass a one and three-fourths (1-3/4”) inch sieve and not more than 12 percent shall pass a No. 200 sieve. Compact embedment materials in six (6”) inch lifts to twelve (12”) inches above the pipe and to a density of at least 95 percent of Standard Proctor Density described by ASTM D698. Test embedment materials for compliance with the above specification and forward test results to the Architect/Engineer.

3.04 MATERIAL HANDLING
A. Proper and adequate implements, tools and facilities satisfactory to the Architect/Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the Work. During the process of unloading, the Contractor shall inspect all pipe and accessories for damage. The Contractor shall notify the Architect/Engineer of all material found to have cracks, flaws or other defects. The Engineer shall inspect the damaged materials and have the right to reject any materials found to be unsatisfactory. The Contractor shall promptly remove all rejected material from the site. All materials shall be handled carefully to prevent damage to protective coatings, linings and joint fillings; preclude contamination of interior areas; and avoid jolting contact, dropping or dumping.
B. All work and materials are subject to tests by the Owner at such frequency as may be determined by the Architect/Engineer. The Owner shall pay for such tests.
C. While suspended and before being lowered into laying position, each pipe section and appurtenant unit shall be inspected by the Contractor to detect damage or unsound conditions that may need corrective action or be cause for rejection. The Contractor shall inform the Architect/Engineer of any defects discovered and the Engineer will prescribe the required corrective actions or order rejection.
D. Immediately before placement, the joint surfaces of each pipe section and fitting shall be inspected for the presence of foreign matter, coating blisters, rough edges or projections and any imperfections so detected shall be corrected by cleaning, trimming or repair as needed.

3.05 INSTALLATION OF SANITARY PIPING
A. Trenching, Backfilling and Compacting.
   1. Trenching and backfilling shall be constructed in accordance with Section 31 2333 - Trench Excavation and Backfill for Utilities.
B. Installing Piping and Appurtenances:
   1. Provide and use the proper implements, tools and facilities for the safe and convenient prosecution of the Work.
2. Unload and distribute materials at the site carefully to prevent materials from being damaged, minimize handling and not hamper construction activities. In no case shall materials be thrown or dumped from the truck.

3. Lower pipe into trench carefully to prevent damage to pipe and protective coatings and linings. Under no circumstances shall pipe be dumped into the trench.

C. Immediately before placement, the joint surfaces of each pipe section and fitting shall be inspected for the presence of foreign matter, coating blister, rough edges and projections, and any other imperfections so detected shall be corrected by cleaning, trimming or repair as required.

D. Pipe shall be laid using laser equipment or grade boards. Grade boards shall be furnished and set by the Contractor according to the established grade stakes. No pipe shall be laid unless there is a minimum of four (4) grade boards set to check the proper grade and alignment ahead. Provide and use a suitable grade rod to ensure the proper grade of the pipe. Grade boards shall be no more than twenty-five (25') feet apart.

E. Pipe shall not be laid in water or when the trench conditions are unsuitable for work. Protect the exposed ends of all pipes with a board or approved stopper to prevent earth or substances from entering the pipe.

F. At the time of pipe placement, the bedding conditions shall be such as to provide uniform and continuous support for the pipe between bell holes. Bell holes shall be excavated as necessary to make the joint connections, but they shall be no larger than would be adequate. Bell and spigot pipe shall be laid with the bell ends facing upgrade and the laying shall start at the downgrade end and proceed upgrade.

G. As each length of bell and spigot pipe is placed in laying position, the spigot end shall be centered in the bell and the pipe forced hole and brought to correct line and grade. The pipe shall be secured in place with approved backfill material, which shall be thoroughly compacted around the pipe. The joint areas shall remain exposed and precautions shall be taken to prevent soil from entering the joint space.

H. Carefully clean the interior of the sewer from dirt, cement or superfluous material of every description as the work progresses. If necessary, thoroughly flush pipe at the completion of the Work.

I. When existing utility structures or branch connections leading to main sewers or to main drains present obstructions to the grade and alignment of the pipe, they shall be permanently supported, removed, relocated or reconstructed.

J. When water main, water services and sewer services, whether lowered or existing, are in danger of freezing due to proximity of storm sewers, catch basin leads or storm sewer structures, the Architect/Engineer may direct the placement of insulation between the storm sewer and the water main or service pipe at no additional cost to the Owner or the Owner's representative.

K. The interior of all pipe shall, as the work progresses, be cleaned of all dirt and superfluous materials. The exposed end of the pipe shall be protected with suitable temporary covers. Pipe laid in place shall be protected from injury and disturbance.

3.06 PIPE JOINTING

A. Make joints for PVC by the use of push-on rubber gaskets. Jointing procedures shall be in accordance with the recommendations of the pipe manufacturer. Spigot ends shall be marked as necessary to indicate the point of complete closure.
B. Watertight and airtight joints are required, without concrete encasement, the joints shall be sealed as follows; subject to such other approved method as the Architect/Engineer may authorize as being an acceptable alternative:

1. Smooth wall PVC pipe and fittings - assembled push-on gasketed joints shall pass performance tests as listed in ASTM D3212. Solvent welds shall not be permitted.

C. Watertight and airtight joints are required.

3.07 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under the provisions of Division One Specifications.

B. General:

1. All pipe will be visually inspected.

2. All visible leaks shall be repaired.

3. Broken or cracked pipe, mislaid pipe and other defects shall be corrected.

4. All repairs, relaying of sewers, etc. required to bring the sewers to specified status shall be made at no additional cost to the Owner or the Owner's representative.

5. Testing all sewer piping must comply with the construction requirements of the Minnesota Plumbing Code.

C. Inspection:

1. Request inspection prior to and immediately after placing aggregate cover over pipe.

2. Compaction testing will be performed in accordance with ASTM D698.

3. Clean and prepare for inspection each block or section of sewer upon completion, or at such other time as the Architect/Engineer may direct.

D. If tests and inspections indicate that the Work does not meet the specified requirements, remove Work, replace and retest at no cost to the Owner or the Owner's representative.

3.08 TESTING/INSPECTION

A. All testing shall be witnessed by the local Plumbing Inspector and the Owner's Representative or the Architect/Engineer. The Contractor shall provide forty-eight (48) hours’ notice to the Owner's Representative or the Architect/Engineer prior to conducting tests.

B. Visual Inspection:

1. Sanitary sewer pipes shall be straight and uniform in alignment and grade. Pipe and manholes shall be free of dirt, mortar and other debris.

C. Deflection Test:

1. Deflection tests shall be performed on all plastic gravity sewer pipes. The test shall be conducted after the sewer trench has been backfilled to the desired finished grade and has been in place for 30 days.
2. The deflection test shall be performed by pulling a rigid ball or pointed mandrel through the pipe without the aid of mechanical pulling devices. The ball or mandrel shall have a minimum diameter equal to 95 percent of the actual inside diameter of the pipe. The maximum allowable deflection shall not exceed 5 percent of the pipes internal diameter. The time of the test, methods of testing and the equipment to be used for the test shall be subject to the approval of the Architect/Engineer.

3. The Contractor at their expense shall perform all testing without any direct compensation being made therefore and they shall furnish all necessary equipment and materials required.

4. Test Failure and Remedy: Any test section that fails shall be replaced, with all repair work subject to the approval of the Architect/Engineer. The replaced section shall be re-tested for leakage and deflection in conformance with the Specifications contained herein.

5. All repairs, replacement and re-testing shall be at the Contractor's expense.

D. Sanitary Sewer Leakage Testing

1. All sanitary sewer lines, including service connections, shall be substantially watertight and shall be tested for excessive leakage upon completion and before connections are made to the service by others. Each test section of the sewer shall be subjected to exfiltration testing, either by hydrostatic or air test method as described below and at the Contractor's option. The requirements set forth for maximum leakage shall be met as a condition for acceptance of the sewer section represented by the test.

2. If the ground water level is greater than three (3') feet above the invert elevation of the upper manhole and the Architect/Engineer so approves, infiltration testing may be allowed in lieu of the exfiltration testing, in which case the allowable leakage shall be the same as would be allowed for the Hydrostatic Test.

3. The Contractor shall perform all testing without any direct compensation being made therefore and the Contractor shall furnish all necessary equipment and materials, including plugs and standpipes as required.

4. Air Test Method:
   a. The sewer pipe section under test shall be clean at the time of testing but the pipe may be wetted. Pneumatic balls shall be used to plug the pipe ends at the manholes. Low pressure air shall be introduced into the plugged lines until the internal air pressure reaches four (4.0) pounds per square inch greater than the average back pressure of any ground water pressure that may submerge the pipe. At least two (2) minutes shall be allowed for the air temperature to stabilize before readings are taken and the timing started. During this time the Contractor shall check all plugs with soap solution to detect plug leakage. If plugs are found to leak, air shall be bled off, the plugs shall be re-tightened and the air shall be reintroduced into the line.
   b. The sewer section under test will be accepted as having passed the air leakage test if it does not lose air at a rate to cause the pressure to drop from three and six-tenths (3.6) to three (3.0) pounds per square inch in less time than one-half minute per inch in diameter of the pipe tested.
5. Hydrostatic Test Method:
   a. After bulkheading the test section, the pipe shall be subjected to a hydrostatic pressure produced by a head of water at a depth of three (3') feet above the invert elevation of the sewer at the manhole of the test section. In areas where ground water exists, this head of water shall be three (3') feet above the existing water table.
   b. The water head shall be maintained for a period of one (1) hour during which time it will be presumed that full absorption of the pipe body has taken place and thereafter for an extended period of one (1) hour the water head shall be maintained as the test period. During the one (1) hour test period, the measured water loss within the test section, including service stubs, shall not exceed the Maximum Allowable Loss (in Gallons Per Hour per one hundred (100') feet of Pipe) given below for the applicable Main Sewer Diameter.

<table>
<thead>
<tr>
<th>Diameter (In Inches)</th>
<th>Maximum Allowable Loss* (In Gallons Per Hour Per 100-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.5</td>
</tr>
<tr>
<td>8</td>
<td>0.6</td>
</tr>
</tbody>
</table>

*Based on 100 gallons per day per pipe diameter inch per mile

E. If measurements indicate exfiltration within a test action section is not greater than the allowable maximum, the section will be accepted as passing the test.

F. Testing Failure and Remedy:
   1. In the event of test failure on any test section, testing shall be continued until all leakage has been detected and corrected to meet the requirements. All repair work shall be subject to the approval of the Architect/Engineer. Introduction of sealant substances by means of the test water will not be permitted.
   2. Unsatisfactory repairs or test results may result in an order to remove and replace pipe as the Architect/Engineer considers necessary for test conformance. All repair and replacement work shall be at the Contractor's expense.

G. Televising:
   1. Sewer line televising may be required by the Architect/Engineer, at the cost of the Contractor, if visual inspection, leakage testing or deflection testing indicate the sewer has not been constructed in accordance with these Specifications and the requirements of the Plans, Specifications and Special Provisions.

3.09 PROTECTION
A. Protect finished installation under the provisions of Division One Specifications.
B. General Requirements: Protect sanitary drainage system from damage and construction operations until date of Substantial Completion.

END OF SECTION
SECTION 33 4000
STORM DRAINAGE UTILITIES

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Site storm drainage construction to buildings and municipal storm drainage: including all pipes, fittings, attachments and connections needed for a complete and proper installation.
C. Drain Tile Systems.
   1. Perforated Polyvinyl Chloride (PVC) Pipe.
D. Storm drainage piping for surface, or a combination of surface and subsurface water;
   1. Polyvinyl Chloride (PVC) Pipe.
E. Storm sewer structures, covers, grates and frames.
   1. Concrete Catch Basins.
   2. Concrete Manholes.
F. Protection of completed system against sedimentation during subsequent construction activities.

1.02  RELATED SECTIONS
A. Section 02 4113 - Selective Site Demolition.
B. Section 31 2333 - Trenching and Backfilling.
C. Section 33 3000 - Sanitary Sewerage Utilities.

1.03  REFERENCES
A. ACI 301 - Specifications for Structural Concrete; 2016.
M. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
N. Minnesota Department of Transportation 2016 Edition "Standard Specifications for Construction". Only applicable portions of construction methods and materials apply. References to methods of measurement or payment are not applicable.

1. MN/DOT 3149 - Granular Material
2. MN/DOT 3733 - Geotextiles


1.04 QUALITY ASSURANCE

A. All Work of this section occurring on public property shall be constructed in accordance with the laws, ordinances, rules, regulations, and orders of any public authority having jurisdiction. All Work required to be constructed by regulatory authorities in a manner differing from the Contract Documents shall be considered part of the Base Bid Contract.

B. Conform to all applicable code for materials and installation of the Work of this Section.

C. Verify that survey bench mark and intended elevations for the Work are as indicated.

D. The Contractor is responsible for coordinating construction schedule and required testing with testing agency prior to start of construction.

E. Record location of pipe sizes, materials and runs, connections, manholes, cleanouts and invert elevations.

F. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

G. The Contractor is to employ the services of a Registered Land Surveyor to perform the specified layout work.

H. Record Drawings:
   1. Refer to "Submittals" and "Field Quality Control" of this Section.

1.05 FIELD MEASUREMENTS

A. Verify actual locations of storm sewage systems with other construction in which sewage systems must fit by accurate field measurements before installation. Coordinate installation schedule with construction progress to avoid delay of the Work. No additional compensation will be given for problems resulting from Contractor's failure to verify and/or coordinate storm sewer work.
1.06 SUBMITTALS
A. Submit under the provisions of Division One Specifications.
B. Shop Drawings: The Contractor shall submit a Shop Drawing portfolio showing all piping, fittings, manholes, covers, etc. provided under this Section prior to construction.
C. Record Drawings: The Contractor shall mark, in red pencil or ink, field changed made in the Contract Drawings. One set of clean prints shall be used for this purpose. This set of prints shall not be used for construction purposes and shall be kept as clean as possible.
   1. The record drawing shall be submitted after the date of Substantial Completion, prior to project closeout, and prior to the release of retainage Architect/Engineer.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.07 REGULATORY REQUIREMENTS
A. Conform to applicable code for materials and installation of the Work of this section.

1.08 PROJECT CONDITIONS
A. The Contractor shall visit the site and review all Drawings, Specifications, and Geotechnical Report(s) prior to bidding. No additional compensation will be allowed for items that could have been clarified prior to bidding. Requests for clarifications shall be submitted two (2) weeks prior to the bid closing date.
B. Protection of Persons: The Owner's activities will continue about the site during construction. Install barricade fencing, as necessary, to provide a safe environment between construction work and pedestrian circulation.
C. Protection of Existing Property to Remain: Protect existing bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, utilities, and other miscellaneous items that are in areas where Work will be performed and which are to remain. Repair or replace existing property that is to remain that is damaged by the Work of this Contract, to the Architect/Engineer's satisfaction and at no cost to the Owner.
D. Existing Utilities:
   1. Existing utilities currently exist within the construction areas, including waterworks, storm drainage, sanitary sewers, gas mains, and other utilities.
   2. The approximate locations of certain underground lines and structures are shown on the plans based on the topographic survey provided by the Owner. Other underground lines or structures may not be shown.
   3. Locate and mark these and other possible unknown utility lines using Gopher State One Call, electronic pipe finder, contacting property owner or other approved means.
   4. Locate, excavate, and expose all existing underground lines in advance of trenching operations.
5. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these existing utilities in the execution of their Work under this section. All repairs are part of the Base Bid Contract.

E. Traffic Control:

1. Maintain vehicular and pedestrian traffic as required for construction activities.

2. Provide flag men, barricades, warning signs, and warning lights for the movement of traffic and safety and to cause the least interruption of the Work.

3. When working in public right-of-way, the Contractor is responsible for all traffic control and permit requirements. No additional compensation will be allowed to provide these services.

1.09 CONFLICTING UTILITIES

A. When alterations to existing utilities are shown to avoid conflicts, make alterations at no cost to the Owner.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, handle and protect products to the site under the provisions of Division One Specifications.

1.11 WARRANTY

A. Provide one (1) year warranty. Warranty shall be in addition to, and run concurrent with, other warranties required by the Contract Documents, including the Division One Specifications. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under the requirements of the Contract Documents.

B. Warranty: State that all materials and workmanship provided are guaranteed against defects after completion and final acceptance of the Work. Defects due to faulty materials or workmanship developed during the guarantee period shall be satisfactorily repaired or replaced at no additional expense to the Owner.

PART 2 PRODUCTS

2.01 PIPE AND MATERIAL

A. General:

1. Materials required for this Work shall be new materials conforming to the requirements of the referenced Specification for the class, kind, type, size, grade and other details indicated on the Drawings.

2. Wherever connection of dissimilar materials or design is required, the method of joining and any special fittings employed shall be subject to approval by the Architect/Engineer.

3. The Drawings indicate various lengths of storm sewer. These dimensions are from center of structure to center of structure, and include pipe end sections. The Contractor is to verify the pipe lengths prior to bidding.
B. PVC Pipe: Pipe and fittings shall conform to the requirements of ASTM D3034, Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings, SDR 26. The pipe shall be joined with a bell and spigot with elastomeric gasket joint in accordance to ASTM D3212. The spigot end shall be marked so that the installer and the observer can determine when the pipe is properly fitted. The pipe shall be installed in accordance to ASTM D2321.

C. Drain Tile:


2. Granular material for subdrain pipe shall meet the requirements of Mn/DOT Specification 3149.2.H Coarse Filter Aggregate.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>85-100</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>30-60</td>
</tr>
<tr>
<td>#4</td>
<td>0-10</td>
</tr>
</tbody>
</table>

   a. Minimum Grab Tensile Strength in Either Direction: 100 pounds ASTM D4632/D4632M.
   b. Minimum Seam Breaking Strength: 90 pounds ASTM D4632/D4632M.
   d. Minimum Permittivity: 0.7 minimum G per second (falling head) ASTM D4491.

4. Perforations: When perforated drain tile pipe is specified, perforations shall conform to the following requirements unless otherwise specified.
   a. Perforations shall be either circular or slots.
   b. Circular perforations shall be quarter (1/4") inch plus or minus sixteenth (1/16") inch diameter holes arranged in rows parallel to the axis of the pipe. Perforations shall be evenly spaced along each row such that the center-to-center distance between perforations is not less than eight times the perforation diameter. Perforations may appear at the ends of short and random lengths. The minimum perforation opening per foot of pipe shall be as shown in perforations table.
   c. Rows shall be arranged in two equal groups at equal distance from the bottom on each side of the vertical centerline of the pipe. The lower-most rows of perforation shall be separated by an arc of not less than 60 degrees or more than 125 degrees. The uppermost rows of perforations shall be separated by an arc not to exceed 166 degrees. The spacing of rows between these limits shall be uniform. The minimum number of rows shall be as shown in the perforations table.
   d. Slot perforations shall be symmetrically located in two rows, one on each side of the pipe centerline. Slot perforations shall be located within the lower quadrants of the pipe with slots no wider than one eighth (1/8") inch and spaced not to exceed eleven (11) times the perforation width. Minimum perforation opening per lineal foot of pipe shall be as shown in the perforations table.
   e. On both the inside and outside of the pipe, perforations shall be free of cuttings or frayed edges and of any material that would reduce the effective opening.
<table>
<thead>
<tr>
<th>Nominal Pipe Size (In)</th>
<th>Minimum Number of Rows</th>
<th>Minimum Opening Per Foot (square inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Circular</td>
<td>Slot</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>2</td>
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<tr>
<td>8</td>
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</tr>
<tr>
<td>10</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

D. Concrete: Concrete shall be minimum 4,500 pounds per square inch air-entrained concrete, meeting the requirements of ACI 301.

2.02 PRECAST CONCRETE MANHOLE/CATCH BASIN

A. Precast concrete riser sections and appurtenant units (grade rings, top and base slabs, special sections, etc.) used in the construction of manhole/catch basin structures shall conform with the requirements of ASTM C478, subject to the following supplementary provisions:

1. The precast sections and appurtenant units shall conform to all requirements as shown on the Detailed Drawings.

2. The joints of structure riser sections shall be tongue and groove with rubber “O” ring joints provided on storm sewer structures. Storm sewer inlet and outlet pipes shall be joined to the structure with a gasketed, flexible, watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and structure wall to take place.

3. Air-entrained concrete shall be used in the production of all units. Air content shall be maintained within the range of 5 to 7 percent.

4. A Certificate of Compliance shall be furnished with each shipment of precast manhole and catch basin sections stating that the materials furnished have been tested and are in compliance with the Specification requirements.

5. Lift holes will be permitted in precast manholes/catch basins.

B. Manhole Steps

1. All manhole steps shall conform to Neenah Foundry Step No. R-1981J in dimension and strength. Manhole steps shall be spaced 16” on center on the downstream face of the manhole unless specified otherwise. Cast iron manhole steps shall be manufactured from high test metal having a minimum tensile strength of 35,000 pounds per square inch. Provide steps having non-skid top surfaces, safety stops at each end, minimum width of ten (10”) inches and not less than five (5”) inches projections from the wall.
2. Aluminum manhole steps of a design similar to the cast iron steps specified may be used. Aluminum manhole steps shall be made of Apex Ternalloy No. 5 aluminum alloy. Aluminum steps shall support one thousand (1,000) pound load at center with no deformation, coat embedded ends with bituminous paint.

3. Copolymer Polypropylene plastic manhole steps (PSI-PF) or equal may be used.

C. Frames and Covers:

1. Provide gray iron castings, complying with ASTM A48/A48M, Class 30 iron.


3. Provide frames weighing not less than 208 pounds with inside opening between twenty-one (21") inches and twenty-four (24") inches.

4. Covers to have the words “STORM SEWER” in two (2") inch high letters cast in the metal.

5. Where indicated on plans, provide watertight covers with a minimum of two “pick” holes conforming to above requirements and with frame tapped for four (4) bolts, countersunk in cover.
   a. Provide rubber gasket between frame and cover.

6. Unless otherwise specified, provide vented circular cover with a minimum of two “pick” holes and weighing not less than one hundred twenty (120) pounds.

7. Covers must fit closely on the adjusting rings so there will be no rocking from pressure applied on the cover.

D. Invert Shaping Grout: One part Type 1, ASTM C150/C150M, cement by volume, two parts clean and sharp, ASTM C33/C33M, sand by volume, and 12 parts 1/4" ASTM C33/C33M, aggregate by volume.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which the Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 LAYING OUT WORK

A. Provide all materials, labor, instruments, etc. required to lay out the Work.

B. The Contractor is to employ the services of a Registered Land Surveyor to perform specified layout work.

C. Promptly inform the Architect/Engineer of discrepancies found, in order that proper corrections may be made.
3.03 BEDDING

A. Install and bed PVC pipe in accordance with ASTM D2321, Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe. Embedment materials shall be Class I or Class II. These materials shall pass a one and three-fourths (1-3/4") inch sieve and not more than 12 percent shall pass a No. 200 sieve. Compact embedment materials in six (6") inch lifts to twelve (12") inches above the pipe and to a density of at least 95 percent of Standard Proctor Density described by ASTM D698. Test embedment materials for compliance with the above specification and forward test results to the Architect/Engineer.

3.04 INSTALLATION OF STORM PIPING

A. Trenching, Backfilling and Compacting.
   1. Trenching and backfilling shall be constructed in accordance with Section 31 2333 - Trench Excavation and Backfill for Utilities.

B. Installing Piping and Appurtenances:
   1. Provide and use the proper implements, tools and facilities for the safe and convenient prosecution of the Work.
   2. Unload and distribute materials at the site carefully to prevent materials from being damaged, minimize handling and not hamper construction activities. In no case shall materials be thrown or dumped from the truck.
   3. Lower pipe into trench carefully to prevent damage to pipe and protective coatings and linings. Under no circumstances shall pipe be dumped into the trench.

C. Immediately before placement, the joint surfaces of each pipe section and fitting shall be inspected for the presence of foreign matter, coating blister, rough edges and projections, and any other imperfections so detected shall be corrected by cleaning, trimming or repair as required.

D. Pipe shall be laid using laser equipment or grade boards. Grade boards shall be furnished and set by the Contractor according to the established grade stakes. No pipe shall be laid unless there is a minimum of four (4) grade boards set to check the proper grade and alignment ahead. Provide and use a suitable grade rod to ensure the proper grade of the pipe. Grade boards shall be no more than twenty-five (25') feet apart.

E. Pipe shall not be laid in water or when the trench conditions are unsuitable for work. Protect the exposed ends of all pipes with a board or approved stopper to prevent earth or substances from entering the pipe.

F. At the time of pipe placement, the bedding conditions shall be such as to provide uniform and continuous support for the pipe between bell holes. Bell holes shall be excavated as necessary to make the joint connections, but they shall be no larger than would be adequate. Bell and spigot pipe shall be laid with the bell ends facing upgrade and the laying shall start at the downgrade end and proceed upgrade.

G. As each length of bell and spigot pipe is placed in laying position, the spigot end shall be centered in the bell and the pipe forced hole and brought to correct line and grade. The pipe shall be secured in place with approved backfill material, which shall be thoroughly compacted around the pipe. The joint areas shall remain exposed and precautions shall be taken to prevent soil from entering the joint space.
H. Carefully clean the interior of the sewer from dirt, cement or superfluous material of every description as the work progresses. If necessary, thoroughly flush pipe at the completion of the work.

I. When existing utility structures or branch connections leading to main sewers or to main drains present obstructions to the grade and alignment of the pipe, they shall be permanently supported, removed, relocated or reconstructed. Work shall be considered part of the base bid contract.

J. When water main, water services and sewer services, whether lowered or existing, are in danger of freezing due to proximity of storm sewers, catch basin leads or storm sewer structures, the Architect/Engineer may direct the placement of insulation between the storm sewer and the water main or service pipe at no additional cost to the Owner or the Owner's representative.

K. Rigid polystyrene insulation board shall be installed on all storm sewer stubs servicing the building where less than 5-feet of cover exists over the top of the pipe.

L. Openings along the line of the storm sewer shall be securely closed, and at the suspension of the Work at any time, suitable stops shall be placed to prevent earth or any substance from entering the storm sewer. If water is present in the trench, the seals shall remain in place until the trench is completely dry.

M. The interior of all pipe shall, as the work progresses, be cleaned of all dirt and superfluous materials. The exposed end of the pipe shall be protected with suitable temporary covers. Pipe laid in place shall be protected from injury and disturbance.

3.05 MANHOLE/CATCH BASIN PRECAST STRUCTURES

A. Set bases level so that walls will be plumb.

B. Apply joint sealer or ring gasket to wall section(s) and set firmly in place to assure watertight joints.

C. Form manhole invert channels directly in the concrete of the structure base, with mortar. Smooth the floor of the manhole outside the channels, and slope toward the channels at not less than one (1") inch per foot and not more than two (2") inches per foot.
   1. Shape the invert channels to be smooth and semicircular, conforming to the inside of the adjacent sewer section.
   2. Make changes in direction of flow with a smooth curve of as large a radius as the size of the manhole will permit.
   3. Make changes in size and grade of channels smoothly and evenly.
   4. Slope invert uniformly from invert of inlet to invert of outlet.

D. Unless otherwise specified or approved, catch basins and manholes shall be constructed on a precast concrete base and the barrel riser sections, cone section and top adjusting rings shall all be of precast concrete. All units shall be properly fitted and sealed to form a completely watertight structure. Barrel and cone height shall be such as to permit placement of at least two (2) and not more than four (4) standard two (2") inch precast concrete adjusting rings immediately below the casting assembly which shall be set in a mortar bed. Each adjusting ring shall also be set in mortar. No blocks will be allowed to raise casting and frame.

E. Resilient rubber boot seals shall be used to make watertight connections to manholes, catch basins and other structures. Cement mortar joints are permitted only for repairs and connections of existing lines constructed with such joints.
F. Provide water tight connection to manholes, catch basins, and other structures. Follow all manufacturer's recommendations.

### 3.06 BUILT-IN-PLACE STRUCTURES

A. All structures are to be precast concrete unless specifically allowed by the Architect/Engineer.

### 3.07 SUB-SURFACE DRAIN

A. Sub-surface drain construction shall be performed in accordance with the provisions of MN/DOT 2502, except as modified below and as detailed on the Drawings:

1. The pipe shall be installed at the locations indicated on the Drawings, or as determined at the time of the construction operations to drain the subgrade and granular backfill.

2. The pipe may be furnished with either bell or spigot joints or with sleeve couplings on the straight pipe. All joints in the perforated pipe shall be left unsealed.

3. To prevent infiltration of soil and aggregate into the pipe, the perforated pipe and rock pack shall be wrapped with strong, porous, rot proof geotextile filter fabric, the openings in which will be compatible with the gradation of the backfill material.

4. The filter fabric shall meet the requirements of MN/DOT Specification Section 3733 Geotextiles Type I. Torn or punctured fabric shall not be accepted and in no case shall the fabric be exposed to heat or direct sunlight to the extent that its strength or toughness is diminished.

5. The over-wrapping and securing of the filter cloth to the pipe shall be done in a manner approved by the Independent Testing Inspector. Spiral wrapping of the filter cloth on the pipe will not be permitted.

### 3.08 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under the provisions of Division One Specifications.

B. General:

1. All pipes shall be visually inspected.

2. All visible leaks shall be repaired.

3. Broken or cracked pipe, mislaid pipe and other defects shall be corrected.

4. All repairs, relaying of sewers, etc. required to bring the sewers to specified status shall be made at no additional cost to the Owner or the Owner’s representative.

5. Testing all manholes, catch basins and storm sewer piping must comply with the construction requirements of the Minnesota Plumbing Code, 4714.

C. Inspection:

1. Request inspection prior to and immediately after placing aggregate cover over pipe.

2. Compaction testing will be performed in accordance with ASTM D1557.
3. Clean and prepare for inspection each block or section of sewer upon completion, or at such other time as the Architect/Engineer may direct.

D. If tests indicate that Work does not meet specified requirements, remove Work, replace and retest at no additional cost to the Owner or the Owner's representative.

3.09 ADJUSTING AND CLEANING
A. Correcting Deficiencies: Correct imperfections and irregularities in Work at no expense to the Owner.

B. Cleaning Drains: Drains shall be free of silt, debris and other obstructions at the time of final acceptance.

C. Cleaning Site: Remove excess earth, excess construction materials, construction equipment and construction debris, which is related to this Work, from the site at the completion of the work.

D. The Contractor shall clean all sumps after final surfaces are established and prior to project closeout.

3.10 PROTECTION
A. Protection of finished work under provisions of Division One Specifications.

B. General Requirements: Protect storm drainage system from damage and construction operations until date of Substantial Completion.

END OF SECTION