

**Unit Well 19 Treatment System Addition**

**Madison Water Utility  
Madison, Wisconsin**

**SEH No. MADWU 167818  
Contract No. 9289  
Project No. 10448  
MUNIS No. 10448-86-140**

**October 12, 2023**



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GEOTECHNICAL DATA

**PART 1 GENERAL**

**1.01 GEOTECHNICAL DATA**

- A. Portions of reports and drawings used by the Engineer in the preparation of the Bidding Documents are attached to this document.
- B. Bidders are responsible for their own interpretation, verification and use of the Technical Data contained in these reports and drawings.
- C. Attached to this Section:
  - 1. Report dated January 20, 2023, consisting of 33 pages, prepared by CGC, Inc., titled:  
Geotechnical Exploration Report  
Treatment System Building Addition  
Unit Well 19  
Madison, WI

**1.02 FOUNDATION BORING NOTES**

- A. Data shown on boring logs is for the Bidders' information. Bidder should be cognizant that materials between borings can vary from that shown on logs. Final and complete identification of all materials between borings can be verified only by Site excavation. Bidder shall assume full responsibility for excavating all materials encountered during construction regardless of density or groundwater condition.
- B. The boring logs are an exact copy of the originals made by photo process reproduction. This information was obtained for design purposes and is made available to Bidders so they may have the same information the designers used. This information is not intended as a substitute for Bidder's personal investigations, interpretations, or judgment. Bidder may make his own soils investigation, but he must first obtain Engineer's approval. Failure of Bidder to conduct his own investigation or to analyze available data shall not relieve Bidder of any responsibility in excavating difficult materials.
- C. Water levels indicated on the boring logs are subject to seasonal and/or annual variations.
- D. The original investigation report is available for Bidder's inspection at Engineer's office.

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Construction • Geotechnical  
Consulting Engineering/Testing

January 20, 2023  
C22051-10

Ms. Kelly Miess  
Madison Water Utility  
119 East Olin Avenue  
Madison, WI 53713-1431

Re: Geotechnical Exploration Report - UPDATED  
Treatment System Building Addition  
Unit Well 19  
Madison, WI

Dear Kelly:

Construction • Geotechnical Consultants, Inc. (CGC) has completed the subsurface exploration program for the above-referenced project. The purpose of this program was to evaluate the subsurface conditions within the proposed construction area and to provide geotechnical recommendations regarding site preparation, foundation, floor slab and pavement design/construction. A determination of the site class for seismic design is also included. We are sending you an electronic copy of this report, and we can provide a paper copy upon request.

### **PROJECT AND SITE DESCRIPTION**

We understand a new building addition is planned along the northeast side of the existing wellhouse building at Unit Well 19, located east of Lake Mendota Drive in Madison, Wisconsin. A backwash tank is also proposed north of the new building addition. The area of the proposed building addition and backwash tank is currently mantled with grass or asphalt pavement. Existing site grades generally slope up from the southeast to northwest, with current ground surface elevations within the limits of the proposed construction ranging between approximately EL 896 and 905 ft, based on 1-ft contour lines shown within DCiMap.

It is understood that the new building addition will be a single-story, slab-on-grade structure (i.e. without below-grade component), and we anticipate that the finished floor elevation will match the first floor of the existing well house structure near EL 896.4 ft. Perimeter foundations are generally expected to bear about 4 to 5 ft below the finished slab elevation. However, based on the presence of a partial below-grade level which extends up to about 17.6 ft below current first floor slab elevation, new foundations adjacent to the current well house may bear slightly deeper.

Furthermore, a backwash tank will also be constructed just north of the new building addition. The base of the cast-in-place concrete tank has been set at EL 890.5 ft, or up to about 15 ft below existing site grades in the vicinity of the tank. The 10-ft tall tank has plan dimensions of 40 ft by 24 ft.

## SUBSURFACE CONDITIONS

Subsurface conditions for this study were explored by drilling seven Standard Penetration Test (SPT) soil borings at locations selected and field-staked by Madison Water Utility (MWU) personnel. The soil borings were conducted by Soil Essentials, Ltd. (under subcontract to CGC) on August 2, 2022 using a track-mounted rotary drill rig equipped with hollow stem augers and an automatic SPT hammer. The borings were intended to be drilled to depths of 50 ft, but terminated approximately between 25 and 35 ft below current site grades as a result of auger refusal on apparent sandstone bedrock. In addition, five attempts to advance B3 terminated 3 ft or less below ground surface within fill materials on presumed boulders; while B2 terminated 10.5 ft below existing grade on *presumed* bedrock/possible fill/boulders. The specific procedures used for drilling and sampling are described in Appendix A, and the boring locations are shown in plan on the Soil Boring Location Exhibit presented in Appendix B. Ground surface elevations at the boring locations were surveyed by MWU using a GPS rover and as-drilled coordinates are included on individual boring logs.

The subsurface profiles at the boring locations varied to some degree, but the following strata were typically encountered (in descending order):

- About 6 to 8 in. of *topsoil fill*, or 3 in. of *asphalt pavement* over 8 in. of *base course* at B8; over
- About 8 to 24 ft of *fill/probable fill* comprised typically of lean clay, sand and gravel soils, most of which appears to be *excavated highly weathered to weathered sandstone bedrock* from the site. The fill soils were underlain by
- Medium dense to very dense probable *highly weathered to increasingly competent sandstone bedrock* to the level of practical drilling refusal.

The thickness of fill appears to increase with proximity to the existing building and aligns well with the depth of the lower-level slab, indicating the material to have been placed as foundation wall backfill during initial construction. These materials are of similar color and texture to the underlying natural soils/weathered bedrock, which is consistent with the material being obtained during excavation for the underground storage tank and existing well house structure. Although records of fill placement monitoring were not provided, the fill/backfill soils encountered in the borings appear to be reasonably well-compacted (based on SPT blow counts commonly referred to as N-values), with isolated loose to very loose zones identified. Some variability in fill composition, as well as loose and/or soft zones will likely be encountered at and below planned foundation elevations.

The apparent weathered to increasingly competent sandstone bedrock, which was encountered below the fill/probable fill strata in the soil borings, appeared as a sand and gravel mixture in the split-spoon samples. It must be noted that the drilling and sampling procedures can disturb/degrade bedrock, which can make it difficult to distinguish between highly weathered and more competent zones in some cases.

Auger refusal in the borings is assumed to indicate the top of harder/more competent bedrock. In general, the depth and consistency of bedrock should be expected to vary across the site.

Groundwater was not encountered during or upon the completion of drilling. Groundwater levels are expected to fluctuate with seasonal variations in precipitation, infiltration, evapotranspiration, nearby Lake Mendota stages, as well as other factors. In addition, due to the presence of relatively impermeable sandstone bedrock, infiltrating surface water may become perched within overlying soil layers during and following periods of wet weather, leading to temporarily elevated groundwater levels.

A more detailed description of the site soil and groundwater conditions is presented on the soil boring logs attached in Appendix B, which also contain the laboratory test results.

## DISCUSSION AND RECOMMENDATIONS

Subject to the limitations discussed below and based on the subsurface exploration, it is our opinion that the site is generally suitable for the proposed construction and that the planned building addition and backwash tank can be supported by a conventional spread footing and mat/slab foundation systems, respectively. However, *partial undercutting and replacement of unsuitable existing fill/backfill will likely be required below the bottom of some footings, depending on final foundation elevations and evaluation at the time of construction.* Our recommendations for site preparation, foundation, floor slab, below-grade wall and pavement design/construction, along with our assessment of the site class for seismic design, are presented in the following subsections. Additional information regarding the conclusions and recommendations presented in this report is discussed in Appendix C.

### 1. Site Preparation

We recommend that the existing pavement and topsoil be removed from the planned construction areas. Where fill will be placed to establish finished site and/or pavement grades outside of the building footprint, topsoil should also be stripped prior to fill placement, but existing pavement can potentially remain in-place provided it is broken up (i.e., pulverized) to promote drainage.

After pavement removal, topsoil stripping and cutting to grade as needed, exposed soils are generally expected to consist of existing sand and clay fill in proximity to the existing structure, potentially natural clay or sand (including weathered sandstone bedrock), further away from the existing building. In areas remaining at-grade or requiring fill, we recommend that natural granular and existing sand fill soil subgrades be thoroughly recompacted with a large vibratory smooth-drum roller. Clay fill and natural cohesive and fine-grained subgrades should be statically recompacted (i.e., without vibration) and subsequently proof-rolled with a piece of heavy rubber-tire construction equipment, such as a loaded tri-axle dump truck, to check for soft/yielding areas. Soft clay, loose sand or unsuitable existing fill soils should be undercut and replaced with granular backfill densified to at least 95% compaction based on modified Proctor methods (ASTM D1557) in accordance with our Recommended Compacted

Fill Specifications presented in Appendix D. Alternatively, 3-in. dense graded base (DGB) that is placed in loose 10-in. lifts and compacted until deflection ceases can also be used to restore grades in undercut areas.

*The existing surficial fill soils should be carefully evaluated by CGC prior to new fill placement, where required, to check the soils' suitability for foundation and floor slab support. Based on the borings, at least partial undercutting/stabilization of the existing fill soils may be required in some areas in order to create firm and stable subgrades in building and pavement areas. We recommend that the project budget contain a generous contingency for such operations.*

Following the development of a firm and stable subgrade, fill placement where required to establish site, pavement and building grades can proceed. To the extent possible, we recommend using granular soils (i.e., sands/gravels) as structural fill within the building envelope and upper 2± ft in pavement areas because these soils are relatively easy to place and compact in most weather conditions compared to clay/silt soils. Existing sand fill soils are considered suitable for reuse as structural fill, provided they are separated from clayey soils during excavation. Excavated weathered bedrock is also considered suitable for reuse, but should be processed to a nominal size of about 3 in. and contain an adequate amount of fines to fill void space during compaction. Clay and silt soils excavated on-site are generally not recommended as structural fill because moisture conditioning (i.e. aeration by discing and drying) would likely be required to achieve desired compaction levels. This process is highly weather-dependent requiring dry, warm and windy conditions which could delay construction progress. In our opinion, clay/silt soils are best used as fill in landscaping areas. We recommend that structural fill be densified to at least 95% compaction based on modified Proctor methods (ASTM D1557) following Appendix D guidelines. Periodic field density tests should be taken by CGC staff within the fill to document the adequacy of the compaction efforts.

As described previously, highly weathered to weathered sandstone bedrock was encountered in the borings between about 8 and 24 ft below existing site grades. Practical auger drilling refusal was encountered between about 10.5 and 35 ft on apparent harder, more competent sandstone bedrock. Depending on final building and foundation grades and based on the borings, excavation into the weathered bedrock layers may be required in the vicinity of Boring 2, as well as in the vicinity of the backwash tank excavation where excavation of up to 15 ft (potentially more) below grade will be required. Excavation into weathered, and possibly more competent, bedrock may also be required at deeper utility excavations, or if foundations for the southern wall of the building addition match existing building grades at the lower-level. Note that the depth to the top of highly weathered bedrock, as well as the depth to fairly competent bedrock, should be expected to vary across the site, as shown in the borings. The upper portions of highly weathered to weathered bedrock may behave more like soil, and it has been our experience that as a general "rule of thumb," bedrock excavation to the level of auger refusal (as encountered in the soil borings) can typically be accomplished using conventional earthwork equipment; while excavation below the auger refusal depth typically requires special removal techniques such as chiseling with a hydraulic rock hammer or blasting. Note that the typical rule of thumb may not apply to narrow utility excavations where fractures may be difficult to locate

and exploit. Excavation difficulty may also be experienced where larger cobble to boulder-sized pieces are encountered within existing fill soils. Rock excavation considerations are contained in Appendix E.

We anticipate that deeper tank excavations can generally be sloped back according to OSHA requirements. Excavation slopes are expected to be controlled by the existing fill/backfill and native sand soils with fairly low fines (“P200”) content, typically classified as OSHA “Type C” soils, and slopes of 1.5H:1.0V are expected to be at least temporarily stable. Note that flatter side slopes may be required where perched or seeping water is present that destabilizes the side slopes. *The appropriate excavation side slopes should be determined by a competent person completing the earthwork in accordance with OSHA slope guidelines.* Where space is limited and adequate sloping of excavation sidewalls is not possible (near planned addition or existing building) temporary earth retention/shoring of the excavation will be required. We recommend that earth retention systems be designed by an appropriately qualified, registered professional engineer.

## **2. Building Foundations**

We anticipate that the finished floor elevation of the single-story, slab-on-grade building will be established between about 2 and 7 feet below existing site grades. Conventional spread footings are generally expected to bear at frost depth, a minimum of 4 ft below finished site grades surrounding the building, and foundation grades are therefore expected to be established within existing granular fill/backfill, stiff native clay, or perhaps weathered sandstone bedrock. Although soil borings were not performed within the limits of the structure, based on a proposed base slab elevation of 890.5 ft and surrounding borings, the back wash tank foundation/slab is expected to bear on existing granular backfill soils, as well as highly weathered to weathered sandstone bedrock progressing north away from the existing building and addition.

As previously stated, although the existing fill/backfill soils appear to be generally uniform and fairly firm, foundation subgrades should be carefully evaluated for their foundation support suitability at the time of construction, and *we anticipate that at least partial undercutting and replacement of unsuitable fill and/or marginal native soils may be required below the bottom of some footings. The excavation of a series of shallow test pits around the planned building footprint is recommended at the time of construction to further characterize the composition and strength of the existing fill soils, as well as the potential need for rock excavation at the deeper back wash tank excavation.*

In conjunction with the above recommendations, we recommend the following parameters be used for foundation design for the planned addition and backwash tank:

- Maximum net allowable bearing pressure: 2,500 psf

- Minimum foundation widths:
  - Continuous wall footings: 18 in.
  - Column pad footings: 30 in.
  
- Minimum footing depths below finish site grades:
  - Exterior/perimeter footings: 4 ft
  - Interior footings: no minimum requirement

Further, a subgrade modulus of 150 pci should be used for the backwash tank foundation slab design, with additional details discussed in the Floor Slab section below.

Where new foundations are constructed adjacent to existing footings, consideration should be given to overlapping stresses such that the initial design soil bearing pressure is not exceeded. Further, *care must be exercised not to undermine the existing building during footing and undercut excavations for the new structure. Temporary shoring/earth retention may be required, as previously discussed.*

As subsurface conditions may vary across building footprint, footing subgrades (as well as the previously recommended supplemental test pits) should be checked by a CGC field representative to document that the subgrade soils are suitable for footing support or otherwise advise on corrective measures, such as undercutting. We recommend using a smooth-edged backhoe bucket for footing and undercut excavations. *Where required, the base of undercut excavations should be widened beyond the footing edges at least 0.5 ft in each direction for each foot of undercut depth for stress distribution purposes.* Granular soils, including existing fill and weathered bedrock in a granular matrix, exposed at footing grade or the bottom of undercut excavations, should be thoroughly recompacted with a large vibratory plate compactor (preferably excavator-mounted) prior to backfilling or formwork/concrete placement. Soils potentially susceptible to disturbance from vibratory compaction (e.g., cohesive/fine-grained soils or sands with elevated moisture contents) should be hand-trimmed. Loosened pieces of bedrock or larger cobbles/boulders which cannot be adequately recompacted should be removed. OSHA slope guidelines should be followed if workers need to enter footing or undercut excavations.

As discussed above, we recommend that marginal native soils, organic soils and unsuitable fill soils be undercut and replaced below the bottom of footings, which should be further evaluated during construction via a series of shallow test pits. In general, clays with  $q_p$ -values of less than 1.25 tsf will require undercutting if encountered at and slightly below the bottom of footings proportioned for an allowable bearing pressure of 2,500 psf. In addition, loose or disturbed sand or silt soils that cannot be recompacted satisfactorily should also be undercut at and slightly below footing grades. In order to re-establish footing grades in undercut areas, we recommend using granular backfill compacted to at least 95% compaction based on modified Proctor methods (ASTM D1557), in accordance with the Recommended Compacted Fill Specifications presented in Appendix D. Loose sands (including existing excavated bedrock fill) removed during undercutting are considered suitable for re-use as backfill provided the material is free of clayey or other unsuitable materials. Alternatively, 3-in. DGB

that is placed in loose 10-in. lifts and compacted until deflection ceases can also be used to restore foundation grades.

Provided the foundation design/construction recommendations discussed above are followed, we estimate that total and differential settlements should be on the order of 1.0 and 0.5 in., respectively. Note that slightly higher differential settlement may occur, and possibly over a very short distance, where footing subgrades transition from soil (or highly weathered bedrock) to harder bedrock. It is therefore recommended that the foundations be suitably reinforced in such areas, if encountered.

### **3. Seismic Site Class**

In our opinion, the average soil/bedrock properties in the upper 100 ft of the site (based on N-values greater than 50 blows/ft projected for the weathered to fairly hard/competent bedrock underlying the site) may be characterized as a very dense soil/soft rock profile. This characterization would place the site in Site Class C for seismic design according to the International Building Code and ASCE 7.

### **4. Floor Slab**

Floor slab subgrades at the building addition are generally expected to consist of existing granular fill, stiff clay or perhaps weathered sandstone bedrock. The backwash tank slab/foundation is expected to bear within existing fill or weathered to competent sandstone bedrock. We recommend that granular floor slab subgrades be thoroughly recompacted with a vibratory smooth-drum roller (or other large vibratory compactor) prior to concrete placement. Cohesive and fine-grained floor slab subgrades will require static recompaction (i.e., without vibration) and subsequent proof-rolling. Areas that remain loose after recompaction, or soft/yielding zones observed during proof-rolling, should be undercut and replaced with well-compacted 3-in. DGB or granular fill. *Anticipating that at least some floor slab subgrades will be established within existing fill and/or native clay soils, which are considered moisture-sensitive and susceptible to disturbance from repetitive construction traffic, we recommend that the project budget include a generous contingency for floor slab subgrade improvement.*

To act as a capillary break below the slab, we recommend including a minimum 6-in. thick layer of well-graded sand/gravel with less than 5% by weight passing the No. 200 U.S. standard sieve. Note, however, that some structural engineers require a layer of dense graded base, such as 1¼-in. DGB, rather than sand/gravel below floor slabs to increase the subgrade modulus immediately below the slab. To further reduce the potential for moisture migration through the slab, a plastic vapor barrier can also be utilized. Fill and base layer material below the floor slab should be placed as described in the Site Preparation section of this report. Slabs constructed on a minimum 6-in. thick dense graded base layer may be designed utilizing a subgrade modulus of 150 pci, and a subgrade modulus of 100 pci should be used for the design of slabs that are constructed on a sand/gravel layer. If a higher subgrade modulus is required in more heavily loaded slab areas (including the backwash base slab), the thickness of the base course layer will likely need to be increased. The design subgrade moduli are based on a firm or adequately stabilized, recompacted subgrade such that non-yielding conditions are developed. The

slab should be structurally separated from the footings with a compressible filler and have construction joints and reinforcement for crack control.

## 5. Below-Grade Walls

The recommendations in this section pertain to the design of below-grade backwash tank walls and other below-grade structures (if any). To reduce the build-up of lateral pressures, we recommend that the excavations and below grade structures be backfilled with on-site sands (including excavated sandstone bedrock) or imported granular soils containing less than 12% passing the No. 200 U.S. Standard Sieve (USCS designations SP, SP-SM, GP or GP-GM). To impede the inflow of surface moisture, the final 2 ft of backfill in unpaved areas should consist of a clayey fill cap. The clayey cap (or pavement) should be graded to promote positive drainage away from the walls. Before placing the wall backfill, the exterior walls should be damp-proofed with spray-applied or mopped-on rubber or bituminous sealer. Compaction of the backfill within 3 to 5 ft of the walls should be performed with lightweight equipment to avoid the development of excessive lateral earth pressures. The backfill should generally be compacted to a minimum compaction level of 93% modified Proctor following Appendix D guidelines. However, we recommend a minimum of 95% compaction where shallow footings will bear on the wall backfill, as well as in the upper 2± ft in pavement areas.

Provided the recommendations outlined above are followed, the following parameters should be used for the design of the below grade structures:

**Table 1 – Granular Backfill Parameters**

Moist Unit Weight of Soil Backfill (pcf):	120
Total/Saturated Unit Weight of Soil Backfill (pcf):	130
Buoyant Unit Weight of Soil Backfill (pcf):	68
Angle of Internal Friction (deg):	30
At-Rest Lateral Earth Pressure Coefficient, $K_0$ :	0.5
Active Lateral Earth Pressure Coefficient, $K_a$ :	0.3

## 6. Pavement Design

We anticipate that pavement design will be controlled by the shallow clay soils and existing fill, and subgrades should be prepared as described in the Site Preparation section of this report, with recompaction/proof-rolling completed prior to base course placement. *Due to the presence of existing fill and since the clay soils are considered moisture-sensitive and susceptible to disturbance from repetitive construction traffic, we recommend that the project budget include a generous contingency for subgrade undercutting/stabilization, which may involve about 12 in. of additional coarse aggregate (e.g., 3-in. DGB), potentially over biaxial geogrid (e.g., Tensar BX Type 1 or equivalent).* The areas requiring undercutting/stabilization and the depth of undercutting should be determined in the field by



proof-rolling prior to installing the base course layer, and the need for undercutting/stabilization will likely depend on the weather conditions during construction. The need for undercutting below the pavement section will likely be reduced where site grades are raised at least 2 ft above existing grade with high quality granular fill.

We also anticipate that asphalt pavement on this site will primarily be exposed to automobile traffic with less than one 18-kip equivalent single axle load (ESAL) per day. In view of this, we have assumed Traffic Class I following Wisconsin Asphalt Pavement Association (WAPA) recommendations for parking areas and driveways that are mainly used by light passenger vehicles. However, the driveways may experience heavier traffic loads from maintenance trucks (or similar). For pavement areas where trucks will routinely travel, we have assumed a traffic load of up to 5 ESALs per day and Traffic Class II according to WAPA. The pavement sections summarized in Table 2 below were selected assuming a Soil Support Value “SSV” of about 4.0 for a firm or adequately stabilized fill/clay subgrade and a design life of 20 years.

**TABLE 2 – Recommended Pavement Sections**

Material	Thicknesses (in.)		WDOT Specification <sup>(1)</sup>
	Traffic Class I (Light Duty)	Traffic Class II (Medium Duty)	
Bituminous Upper Layer <sup>(2,3)</sup>	1.75	1.75	Section 460, Table 460-1
Bituminous Lower Layer <sup>(2,3)</sup>	1.75	2.25	Section 460, Table 460-1
Dense Graded Base Course <sup>(2,4)</sup>	8.0	10.0	Sections 301 and 305
<b>Total Thickness</b>	<b>11.5</b>	<b>14.0</b>	

Notes:

- 1) Wisconsin DOT *Standard Specifications for Highway and Structure Construction*, latest edition, including supplemental specifications, and *Wisconsin Asphalt Pavement Association 2020 Asphalt Pavement Design Guide*.
- 2) Compaction requirements:
  - Bituminous concrete: Refer to Section 460-3.
  - Base course: Refer to Section 301.3.4.2, Standard Compaction

- 3) Mixture Type LT (or E-0.3) bituminous; refer to Section 460, Table 460-2 of the *Standard Specifications*.
- 4) The upper 4 in. should consist of 1¼-in. DGB; the bottom part of the layer can consist of 3-in. DGB.

If medium-duty pavement areas are planned, the medium-duty pavement section may be considered across the entire area (including areas that would only require a light-duty section) for constructability purposes. The recommended pavement sections assume regular maintenance (crack sealing, etc.) will occur, as needed. Note that if traffic volumes are greater than those assumed, CGC should be allowed to review the recommended pavement sections and adjust them accordingly. Alternative pavement designs may prove acceptable and should be reviewed by CGC. If there is a delay between subgrade preparation and placing the base course, the subgrade should be recompact.

Where concrete pavement may be used, such as in pavement areas subjected to concentrated wheel loads (e.g., dumpster pads, equipment pad approaches, etc.), we recommend that the concrete be at least 6 in. thick and contain adequate reinforcement for crack control. Concrete slabs underlain by a minimum 6-in. thick dense graded base layer over a firm or stabilized subgrade can be designed utilizing a subgrade modulus of 150 pci.

*If asphalt paving is not planned within some of the proposed traffic areas, we recommend the base course section consist of a minimum 18 in. of aggregate (see Note 4 above).* Further, regular maintenance of gravel (unpaved) traffic areas should also be performed, such as adding additional base course where potholes/bird baths develop or to maintain proper drainage.

## CONSTRUCTION CONSIDERATIONS

Due to variations in weather, construction methods and other factors, specific construction problems are difficult to predict. Soil related difficulties which could be encountered on the site are discussed below:

- Based on the potentially sensitive nature of some of the on-site soils, we recommend that final site grading activities be completed during dry weather, if possible. Construction traffic should be avoided on prepared subgrades to minimize potential disturbance.
- Contingencies in the project budget for subgrade stabilization with coarse aggregate in pavement and floor slab areas should be increased if the project schedule requires that work proceed during adverse weather conditions.

- Earthwork construction during the late fall through early spring could be complicated as a result of wet weather and freezing temperatures. During cold weather, exposed subgrades should be protected from freezing before and after footing construction. Fill should never be placed while frozen or on frozen ground.
- Excavations extending greater than 4 ft in depth below the existing ground surface should be sloped or braced in accordance with current OSHA standards. *Care must be exercised not to undermine the existing building during new foundation and undercut excavations.*
- Based on the water level observations during our field exploration, we do not anticipate that groundwater will be encountered during foundation excavation or utility installation. However, *water accumulating at the bottom of excavations as a result of precipitation or seepage from perched layers, should be quickly removed, with dewatering means and methods being the contractor's responsibility.*
- Although apparent bedrock was encountered in the soil borings, based on assumed building grades we generally do not anticipate that special rock removal techniques will be necessary to complete footing and undercut excavations. However, rock excavation could potentially be required for deeper utility installations. See Appendix E for general information and recommendations pertaining to rock removal.

### RECOMMENDED CONSTRUCTION MONITORING

The quality of the foundation, floor slab and pavement subgrades will be largely determined by the level of care exercised during site development. To check that earthwork and foundation construction proceed in accordance with our recommendations, the following operations should be monitored by CGC:

- Topsoil stripping and subgrade proof-rolling/compaction;
- Fill/backfill placement and compaction;
- Foundation excavation/subgrade preparation; and
- Concrete placement.

\* \* \* \* \*



Geotechnical Exploration Report - Updated  
Unit Well 19 Treatment Addition  
CGC Project No. C22051-10  
January 20, 2023  
Page 12

It has been a pleasure to serve you on this project. If you have any questions or need additional consultation, please contact us.

Sincerely,

**CGC, Inc.**

Alex J. Bina, PE  
Consulting Professional

Tim F. Gassenheimer, PE  
Senior Staff Engineer

- Encl: Appendix A - Field Exploration  
Appendix B - Soil Boring Location Exhibit  
Logs of Test Borings (7)  
Log of Test Boring-General Notes  
Unified Soil Classification System  
Appendix C - Document Qualifications  
Appendix D - Recommended Compacted Fill Specifications  
Appendix E - Rock Excavation Considerations

**APPENDIX A**  
**FIELD EXPLORATION**

## APPENDIX A

### FIELD EXPLORATION

Subsurface conditions for this study were explored by drilling seven (7) Standard Penetration Test (SPT) soil borings to depths of 3 and 35 ft below current site grades, which were sampled at 2.5-ft intervals to a depth of 10 ft and at 5-ft intervals thereafter. The samples were obtained in general accordance with the specifications for standard penetration testing, ASTM D1586, and the specific procedures used for drilling and sampling are described below.

1. Boring Procedures between Samples

The boring is extended downward, between samples, by a hollow-stem auger.

2. Standard Penetration Test and Split-Barrel Sampling of Soils  
(ASTM Designation: D1586)

This method consists of driving a 2-inch outside diameter split-barrel sampler using a 140-pound weight falling freely through a distance of 30 inches. The sampler is first seated 6 inches into the material to be sampled and then driven 12 inches. The number of blows required to drive the sampler the final 12 inches is recorded on the log of borings and is known as the Standard Penetration Resistance.

During the field exploration, the driller visually classified the soil and prepared a field log. *Field screening of the soil samples for possible environmental contaminants was not conducted by the driller as these services were not part of CGC's work scope.* Water level observations were made in each boring during and after drilling and are shown at the bottom of each boring log. Upon completion of drilling, the borings were backfilled with bentonite to satisfy WDNR regulations and the soil samples were delivered to our laboratory for visual classification and limited geotechnical laboratory testing. The soils were visually classified by a geotechnical engineer using the Unified Soil Classification System (USCS). The final boring logs prepared by the engineer, including the laboratory test results, along with a Soil Boring Location Exhibit and a description of the Unified Soil Classification System are presented in Appendix B.

**APPENDIX B**

**SOIL BORING LOCATION EXHIBIT  
LOGS OF TEST BORINGS (7)  
LOG OF TEST BORING-GENERAL NOTES  
UNIFIED SOIL CLASSIFICATION SYSTEM**



Lake Mendota Dr

**Legend**

⊕ Denotes boring location



**Notes**

1. Soil Borings performed by Soil Essentials in August 2022
2. Boring locations are approximate

Scale: Reduced

<b>Date:</b> 9/2022
<b>Job No.</b> C22051-10



**Soil Boring Location Exhibit**  
**Well 19 Treatment System Addition**  
**Madison, WI**





# LOG OF TEST BORING

Project Well 19 Treatment System Addition  
N488239.2 E808126.8  
 Location Madison, WI

Boring No. B1  
 Surface Elevation (ft) 899.3  
 Job No. C22051-10  
 Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE					VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES					
No.	TYPE	Rec (in.)	Moist	N		Depth (ft)	qu (qa) (tsf)	W	LL	PL	LOI
1	█	16	M	8	5	FILL: Brown Sandy Topsoil with Trace Gravel to 0.75' Stiff, Brown Clay to 2.5' Loose to Medium Dense Brown Silty Sand and Gravel with Scattered Cobbles (Sandstone) to 11.5'  Weathered to Competent, Greenish-Brown Sandstone Bedrock  Firm Drilling Beginning at 14.5'  Hard Drilling Beginning at 20.5'  End of Boring at 25 ft Due to Auger Refusal on Competent Bedrock  Backfilled with Bentonite Chips	(1.5)				
2	█	13	M	8							
3	█	11	M	13							
4	█	12	M	16							
5	█	8	M	100/3"	15						
6	█	13	M	100/9"	20						
7	█	4	M	100/4"	25						

## WATER LEVEL OBSERVATIONS

While Drilling  NW Upon Completion of Drilling \_\_\_\_\_  
 Time After Drilling \_\_\_\_\_  
 Depth to Water \_\_\_\_\_  
 Depth to Cave in \_\_\_\_\_ **12.8'**

## GENERAL NOTES

Start 8/2/22 End 8/2/22  
 Driller SE Chief CRJ Rig 7822DT  
 Logger Ben Editor ESF  
 Drill Method 2.25" HSA; Autohammer

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.



# LOG OF TEST BORING

Project Well 19 Treatment System Addition  
N488259.9 E808121.2  
 Location Madison, WI

Boring No. B2  
 Surface Elevation (ft) 903.1  
 Job No. C22051-10  
 Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE					VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES									
No.	TYPE	Rec (in.)	Moist	N		Depth (ft)	qu (qa) (tsf)	W	LL	PL	LOI				
1	█	16	M	8	5	FILL: Brown Sandy Topsoil to 0.8' Stiff Brown Clay with Sand and Gravel to 3'  Very Loose Brown Silty Sand to 5'  Medium Dense Brown Silty Sand and Gravel with Scattered Cobbles (Sandstone) to 8'					(1.75)				
2	█	7	M	2											
3	█	14	M	15											
4	█	5	M	100/ 6"	10	Apparent Weathered to Competent, Greenish-Brown Sandstone Bedrock Hard Drilling Beginning Near 9' (Possible Fill)  End of Boring at 10.5 ft Due to Auger Refusal on Preumed Bedrock/Possible Boulder  Backfilled with Bentonite Chips									

WATER LEVEL OBSERVATIONS	
While Drilling <input checked="" type="checkbox"/> <u>NW</u> Time After Drilling _____ Depth to Water _____ Depth to Cave in _____	Upon Completion of Drilling _____ _____ _____

GENERAL NOTES	
Start <u>8/3/22</u> End <u>8/3/22</u> Driller <u>SE</u> Chief <u>CRJ</u> Rig <u>7822DT</u> Logger <u>Jeff</u> Editor <u>ESF</u> Drill Method <u>2.25" HSA; Autohammer</u>	

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.



# LOG OF TEST BORING

Project Well 19 Treatment System Addition  
N488250.0 E808108.9  
 Location Madison, WI

Boring No. B3  
 Surface Elevation (ft) 902.2  
 Job No. C22051-10  
 Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE					VISUAL CLASSIFICATION and Remarks		SOIL PROPERTIES				
No.	TYPE	Rec (in.)	Moist	N			Depth (ft)	qu (qa) (tsf)	W	LL	PL
1		11	M	42		<p>FILL: Dense Sandy Gravel with Cobbles and Boulders</p> <p>End of Boring at 3 ft Due to Auger Refusal on Presumed Boulder</p> <p style="text-align: center;">Backfilled with Soil Cuttings</p> <p>Note: A total of 5 attempts were made to perform B3 within 14' of the proposed location. Each attempt resulted in auger refusal on presumed boulders 3' or less below existing grade.</p>					

WATER LEVEL OBSERVATIONS	GENERAL NOTES
While Drilling <input checked="" type="checkbox"/> NW Upon Completion of Drilling _____ Time After Drilling _____ Depth to Water _____ Depth to Cave in _____	Start <u>8/3/22</u> End <u>8/3/22</u> Driller <u>SE</u> Chief <u>CRJ</u> Rig <u>7822DT</u> Logger <u>Jeff</u> Editor <u>ESF</u> Drill Method <u>2.25" HSA; Autohammer</u>
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.	



# LOG OF TEST BORING

Project Well 19 Treatment System Addition  
 Location N488216.5 E808123.9  
Madison, WI

Boring No. B7  
 Surface Elevation (ft) 898.2  
 Job No. C22051-10  
 Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE					VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES					
No.	TYPE	Rec (in.)	Moist	N		Depth (ft)	qu (qa) (tsf)	W	LL	PL	LOI
1	█	17	M	4	0-0.75	FILL: Brown Sandy Topsoil to 0.75' Brown Clay to 1.5' Stiff to Soft, Brown Lean CLAY (CL - Probable Fill)	(1.75)				
2	█	16	M	1	0.75-1.5		(0.3)				
3	█	13	M	9	1.5-9	Loose to Medium Dense, Greenish-Brown Silty SAND and GRAVEL, Scattered Cobbles (SM/GM - Probable Sandstone Fill)					
4	█	16	M	15	9-15						
5	█	17	M	10	15-21.5	Weathered to Competent, Greenish-Brown Sandstone Bedrock (Possible Fill to 15')  Firm Drilling Beginning at 15'					
6	█	6	M	100/6"	21.5-25	Hard Drilling Beginning Near 21.5'					
7	█	3	M	100/3"	25-25	End of Boring at 25 ft Due to Auger Refusal on Competent Bedrock  Backfilled with Bentonite Chips					

## WATER LEVEL OBSERVATIONS

While Drilling  NW Upon Completion of Drilling \_\_\_\_\_  
 Time After Drilling \_\_\_\_\_  
 Depth to Water \_\_\_\_\_  
 Depth to Cave in \_\_\_\_\_ **21.7'**

## GENERAL NOTES

Start 8/1/22 End 8/1/22  
 Driller SE Chief CRJ Rig 7822DT  
 Logger Ben Editor ESF  
 Drill Method 2.25" HSA; Autohammer

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.



# LOG OF TEST BORING

Project Well 19 Treatment System Addition  
N488206.3 E808108.9  
 Location Madison, WI

Boring No. B8  
 Surface Elevation (ft) 899.1  
 Job No. C22051-10  
 Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE					VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES									
No.	TYPE	Rec (in.)	Moist	N		Depth (ft)	qu (qa) (tsf)	W	LL	PL	LOI				
					0	3 in. Asphalt Pavement/8 in. Base Course									
1		16	M	5	5	FILL: Stiff to Very Soft Brown Clay to 8'					(1.5)				
2		17	M	2	7						(0.5)				
3		16	M	90/7"	10	Cobbles/Boulders Noted Beginning Near 6.5'					(0.2)				
4		9	M	100/3"	13	Very Dense Brown Silty Sand and Gravel with Scattered Cobbles (Sandstone) to 13'									
5		15	M	14	16	Medium Dense, Greenish-Brown Silty SAND and GRAVEL, Scattered Cobbles (SM/GM - Probable Sandstone Fill) Firm Drilling Beginning Near 16'									
6		17	M	36	22	Weathered to Competent, Greenish-Brown Sandstone Bedrock Hard Drilling Beginning Near 22'									
7		3	M	100/3"	25	End of Boring at 25 ft Due to Auger Refusal on Competent Bedrock  Backfilled with Bentonite Chips									

## WATER LEVEL OBSERVATIONS

While Drilling  NW Upon Completion of Drilling \_\_\_\_\_  
 Time After Drilling \_\_\_\_\_  
 Depth to Water \_\_\_\_\_  
 Depth to Cave in \_\_\_\_\_ **22.1'**

## GENERAL NOTES

Start 8/1/22 End 8/1/22  
 Driller SE Chief CRJ Rig 7822DT  
 Logger Ben Editor ESF  
 Drill Method 2.25" HSA; Autohammer

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.



# LOG OF TEST BORING

Project Well 19 Treatment System Addition  
N488184.8 E808072.9  
 Location Madison, WI

Boring No. B9  
 Surface Elevation (ft) 904.5  
 Job No. C22051-10  
 Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE					VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES					
No.	TYPE	Rec (in.)	Moist	N		Depth (ft)	qu (qa) (tsf)	W	LL	PL	LOI
1		15	M	8	FILL: Brown Sandy Topsoil to 0.75' Medium Stiff Brown Clay with Scattered Gravel and Cobbles to 13'	(0.75)					
2AS		0	M	3							
3		11	M	3			(0.75)				
4		15	M	5	Dense to Loose Greenish-Brown Silty Sand and Gravel with Cobbles (Sandstone) to 24.5'						
5		16	M	44							
6		15	M/W	9							
7		13	M	54	Weathered to Competent, Reddish to Greenish-Brown Sandstone Bedrock Firm Drilling Beginning Near 26'  Hard Drilling Beginning Near 32'						
8		10	M	100/ 5"							
9		3	M	100/ 3"	End of Boring at 35 ft Due to Auger Refusal on Competent Bedrock  Backfilled with Bentonite Chips						

WATER LEVEL OBSERVATIONS	GENERAL NOTES
While Drilling <input checked="" type="checkbox"/> NW Upon Completion of Drilling _____ Time After Drilling _____ Depth to Water _____ Depth to Cave in _____ <b>13.8'</b>	Start <u>8/2/22</u> End <u>8/2/22</u> Driller <u>SE</u> Chief <u>CRJ</u> Rig <u>7822DT</u> Logger <u>Ben</u> Editor <u>ESF</u> Drill Method <u>2.25" HSA; Autohammer</u>
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.	



# LOG OF TEST BORING

Project Well 19 Treatment System Addition  
N488197.9 E808090.6  
 Location Madison, WI

Boring No. **B10**  
 Surface Elevation (ft) 901.4  
 Job No. C22051-10  
 Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE					VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	TYPE	Rec (in.)	Moist	N		Depth (ft)	qu (qa) (tsf)	W	LL	PL
1	█	16	M	6	FILL: Brown Sandy Topsoil to 0.5' Loose Brown Silty Sand and Gravel to 1.5' Stiff to Soft Brown Clay with Scattered Sand and Gravel to 13'  Loose Brown Silty Sand and Gravel with Scattered Cobbles (Sandstone) to 20'  Weathered to Competent, Greenish-Brown Sandstone Bedrock Firm Drilling Beginning Near 20' Hard Drilling Beginning Near 23'  End of Boring at 25 ft Due to Auger Refusal on Competent Bedrock  Backfilled with Bentonite Chips	(2.75)				
2	█	12	M	4		(0.4)				
3	█	14	M	4						
4AS	█	0	M	6						
5	█	16	M	9						
6	█	17	M	8						
7	█	3	M	100/3"						

WATER LEVEL OBSERVATIONS	GENERAL NOTES
While Drilling <input checked="" type="checkbox"/> NW Upon Completion of Drilling _____ Time After Drilling _____ Depth to Water _____ Depth to Cave in _____ <b>16.3'</b>	Start <u>8/2/22</u> End <u>8/2/22</u> Driller <u>SE</u> Chief <u>CRJ</u> Rig <u>7822DT</u> Logger <u>Ben</u> Editor <u>ESF</u> Drill Method <u>2.25" HSA; Autohammer</u>
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.	

**LOG OF TEST BORING**  
*General Notes*

**DESCRIPTIVE SOIL CLASSIFICATION**

Grain Size Terminology

Soil Fraction	Particle Size	U.S. Standard Sieve Size
Boulders .....	Larger than 12" .....	Larger than 12"
Cobbles .....	3" to 12" .....	3" to 12"
Gravel: Coarse.....	¾" to 3" .....	¾" to 3"
Fine .....	4.76 mm to ¾" .....	#4 to ¾"
Sand: Coarse.....	2.00 mm to 4.76 mm.....	#10 to #4
Medium .....	0.42 to mm to 2.00 mm .....	#40 to #10
Fine .....	0.074 mm to 0.42 mm.....	#200 to #40
Silt.....	0.005 mm to 0.074 mm.....	Smaller than #200
Clay.....	Smaller than 0.005 mm.....	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

General Terminology

**Physical Characteristics**  
 Color, moisture, grain shape, fineness, etc.  
**Major Constituents**  
 Clay, silt, sand, gravel  
**Structure**  
 Laminated, varved, fibrous, stratified, cemented, fissured, etc.  
**Geologic Origin**  
 Glacial, alluvial, eolian, residual, etc.

Relative Density

Term            "N" Value  
 Very Loose..... . 0 - 4  
 Loose..... 4 - 10  
 Medium Dense.....10 - 30  
 Dense.....30 - 50  
 Very Dense.....Over 50

Relative Proportions Of Cohesionless Soils

Proportional Term	Defining Range by Percentage of Weight
Trace.....	0% - 5%
Little.....	5% - 12%
Some.....	12% - 35%
And .....	35% - 50%

Consistency

Term	q <sub>u</sub> -tons/sq. ft
Very Soft.....	0.0 to 0.25
Soft.....	0.25 to 0.50
Medium.....	0.50 to 1.0
Stiff.....	1.0 to 2.0
Very Stiff.....	2.0 to 4.0
Hard.....	Over 4.0

Organic Content by Combustion Method

Soil Description	Loss on Ignition
Non Organic.....	Less than 4%
Organic Silt/Clay.....	4 - 12%
Sedimentary Peat.....	12% - 50%
Fibrous and Woody Peat...	More than 50%

Plasticity

Term	Plastic Index
None to Slight.....	0 - 4
Slight.....	5 - 7
Medium.....	8 - 22
High to Very High ..	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test.

**SYMBOLS**

Drilling and Sampling

- CS – Continuous Sampling
- RC – Rock Coring: Size AW, BW, NW, 2"W
- RQD – Rock Quality Designation
- RB – Rock Bit/Roller Bit
- FT – Fish Tail
- DC – Drove Casing
- C – Casing: Size 2 ½", NW, 4", HW
- CW – Clear Water
- DM – Drilling Mud
- HSA – Hollow Stem Auger
- FA – Flight Auger
- HA – Hand Auger
- COA – Clean-Out Auger
- SS - 2" Dia. Split-Barrel Sample
- 2ST – 2" Dia. Thin-Walled Tube Sample
- 3ST – 3" Dia. Thin-Walled Tube Sample
- PT – 3" Dia. Piston Tube Sample
- AS – Auger Sample
- WS – Wash Sample
- PTS – Peat Sample
- PS – Pitcher Sample
- NR – No Recovery
- S – Sounding
- PMT – Borehole Pressuremeter Test
- VS – Vane Shear Test
- WPT – Water Pressure Test

Laboratory Tests

- q<sub>a</sub> – Penetrometer Reading, tons/sq ft
- q<sub>a</sub> – Unconfined Strength, tons/sq ft
- W – Moisture Content, %
- LL – Liquid Limit, %
- PL – Plastic Limit, %
- SL – Shrinkage Limit, %
- LI – Loss on Ignition
- D – Dry Unit Weight, lbs/cu ft
- pH – Measure of Soil Alkalinity or Acidity
- FS – Free Swell, %

Water Level Measurement

- ▽ - Water Level at Time Shown
- NW – No Water Encountered
- WD – While Drilling
- BCR – Before Casing Removal
- ACR – After Casing Removal
- CW – Cave and Wet
- CM – Caved and Moist

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.



# CGC, Inc.

Madison - Milwaukee

## Unified Soil Classification System

### UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

#### COARSE-GRAINED SOILS

(more than 50% of material is larger than No. 200 sieve size)

##### Clean Gravels (Less than 5% fines)



GW

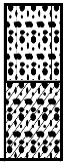
Well-graded gravels, gravel-sand mixtures, little or no fines



GP

Poorly-graded gravels, gravel-sand mixtures, little or no fines

##### Gravels with fines (More than 12% fines)



GM

Silty gravels, gravel-sand-silt mixtures



GC

Clayey gravels, gravel-sand-clay mixtures

**GRAVELS**  
More than 50% of coarse fraction larger than No. 4 sieve size

##### Clean Sands (Less than 5% fines)



SW

Well-graded sands, gravelly sands, little or no fines



SP

Poorly graded sands, gravelly sands, little or no fines

**SANDS**  
50% or more of coarse fraction smaller than No. 4 sieve size

##### Sands with fines (More than 12% fines)



SM

Silty sands, sand-silt mixtures



SC

Clayey sands, sand-clay mixtures

#### FINE-GRAINED SOILS

(50% or more of material is smaller than No. 200 sieve size.)



ML

Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity



CL

Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays



OL

Organic silts and organic silty clays of low plasticity



MH

Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts



CH

Inorganic clays of high plasticity, fat clays



OH

Organic clays of medium to high plasticity, organic silts



PT

Peat and other highly organic soils

**SILTS AND CLAYS**  
Liquid limit less than 50%

**SILTS AND CLAYS**  
Liquid limit 50% or greater

**HIGHLY ORGANIC SOILS**

### LABORATORY CLASSIFICATION CRITERIA

GW  $C_u = \frac{D_{60}}{D_{10}}$  greater than 4;  $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$  between 1 and 3

GP Not meeting all gradation requirements for GW

GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line or P.I. greater than 7	

SW  $C_u = \frac{D_{60}}{D_{10}}$  greater than 4;  $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$  between 1 and 3

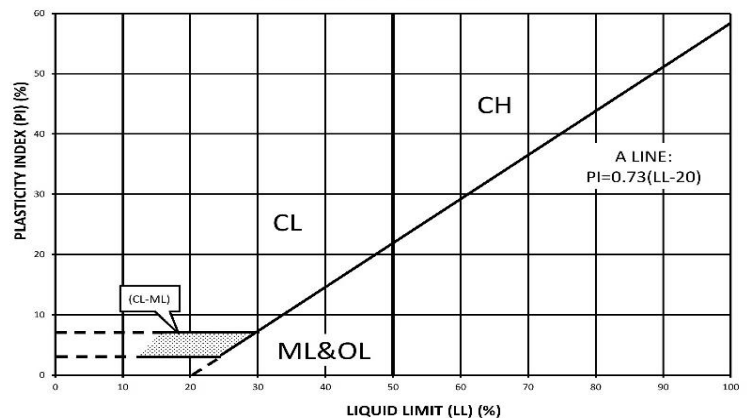
SP Not meeting all gradation requirements for GW

SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP  
More than 12 percent ..... GM, GC, SM, SC  
5 to 12 percent ..... Borderline cases requiring dual symbols

### PLASTICITY CHART



**APPENDIX C**

**DOCUMENT QUALIFICATIONS**

# APPENDIX C

## DOCUMENT QUALIFICATIONS

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### I. GENERAL RECOMMENDATIONS/LIMITATIONS

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CGC, Inc. should be provided the opportunity for a general review of the final design and specifications to confirm that earthwork and foundation requirements have been properly interpreted in the design and specifications. CGC should be retained to provide soil engineering services during excavation and subgrade preparation. This will allow us to observe that construction proceeds in compliance with the design concepts, specifications and recommendations, and also will allow design changes to be made in the event that subsurface conditions differ from those anticipated prior to the start of construction. CGC does not assume responsibility for compliance with the recommendations in this report unless we are retained to provide construction testing and observation services.

This report has been prepared in accordance with generally accepted soil and foundation engineering practices and no other warranties are expressed or implied. The opinions and recommendations submitted in this report are based on interpretation of the subsurface information revealed by the test borings indicated on the location plan. The report does not reflect potential variations in subsurface conditions between or beyond these borings. Therefore, variations in soil conditions can be expected between the boring locations and fluctuations of groundwater levels may occur with time. The nature and extent of the variations may not become evident until construction.

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### II. IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

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Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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.

#### 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.

#### 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. Typical factors include: the client's 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 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. *CGC cannot accept responsibility or liability for problems that occur because our reports do not consider developments of which we were not informed.*

#### SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *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.

#### MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL OPINION

Site exploration identifies 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 judgement 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.

#### **A REPORT'S RECOMMENDATIONS ARE NOT FINAL**

Do not over-rely on the confirmation-dependent recommendations included in your report. *Those confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgement and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *CGC cannot assume responsibility or liability for the report's confirmation-dependent recommendations if we do not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

#### **A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION**

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Confront 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. Constructors can also misinterpret a geotechnical engineering report. Confront that risk by having CGC participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

#### **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 recognize that separating logs from the report can elevate risk.*

#### **GIVE CONSTRUCTORS A COMPLETE REPORT AND GUIDANCE**

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors 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 constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

#### **READ RESPONSIBILITY PROVISIONS CLOSELY**

Some clients, design professionals, and constructors 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 reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineer's 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.

#### **ENVIRONMENTAL CONCERNS ARE NOT COVERED**

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any environmental 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 environmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

#### **OBTAIN PROFESSIONAL ASSISTANCE TO DEAL WITH MOLD**

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention.* *Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

#### **RELY ON YOUR GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE**

Membership in the Geotechnical Business Council (GBC) of Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with CGC, a member of GBC, for more information.

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Geotechnical Business Council  
of the Geoprofessional Business Association  
8811 Colesville Road, Suite G 106  
Silver Spring, MD 20910

**APPENDIX D**

**RECOMMENDED COMPACTED FILL SPECIFICATIONS**

## **APPENDIX D**

### **CGC, INC.**

#### **RECOMMENDED COMPACTED FILL SPECIFICATIONS**

##### **General Fill Materials**

Proposed fill shall contain no vegetation, roots, topsoil, peat, ash, wood or any other non-soil material which by decomposition might cause settlement. Also, fill shall never be placed while frozen or on frozen surfaces. Rock, stone or broken concrete greater than 6 in. in the largest dimension shall not be placed within 10 ft of the building area. Fill used greater than 10 ft beyond the building limits shall not contain rock, boulders or concrete pieces greater than a 2 sq ft area and shall not be placed within the final 2 ft of finish subgrade or in designated utility construction areas. Fill containing rock, boulders or concrete pieces should include sufficient finer material to fill voids among the larger fragments.

##### **Special Fill Materials**

In certain cases, special fill materials may be required for specific purposes, such as stabilizing subgrades, backfilling undercut excavations or filling behind retaining walls. For reference, WisDOT gradation specifications for various types of granular fill are attached in Table 1.

##### **Placement Method**

The approved fill shall be placed, spread and leveled in layers generally not exceeding 10 in. in thickness before compaction. The fill shall be placed at moisture content capable of achieving the desired compaction level. For clay soils or granular soils containing an appreciable amount of cohesive fines, moisture conditioning will likely be required.

It is the Contractor's responsibility to provide all necessary compaction equipment and other grading equipment that may be required to attain the specified compaction. Hand-guided vibratory or tamping compactors will be required whenever fill is placed adjacent to walls, footings, columns or in confined areas.

##### **Compaction Specifications**

Maximum dry density and optimum moisture content of the fill soil shall be determined in accordance with modified Proctor methods (ASTM D1557). The recommended field compaction as a percentage of the maximum dry density is shown in Table 2. Note that these compaction guidelines would generally not apply to coarse gravel/stone fill. Instead, a method specification would apply (e.g., compact in thin lifts with a vibratory compactor until no further consolidation is evident).

##### **Testing Procedures**

Representative samples of proposed fill shall be submitted to CGC, Inc. for optimum moisture-maximum density determination (ASTM D1557) prior to the start of fill placement. The sample size should be approximately 50 lb.

CGC, Inc. shall be retained to perform field density tests to determine the level of compaction being achieved in the fill. The tests shall generally be conducted on each lift at the beginning of fill placement and at a frequency mutually agreed upon by the project team for the remainder of the project.

**Table 1  
Gradation of Special Fill Materials**

Material	WisDOT Section 311	WisDOT Section 312	WisDOT Section 305			WisDOT Section 209		WisDOT Section 210
	Breaker Run	Select Crushed Material	3-in. Dense Graded Base	1 1/4-in. Dense Graded Base	3/4-in. Dense Graded Base	Grade 1 Granular Backfill	Grade 2 Granular Backfill	Structure Backfill
Sieve Size	Percent Passing by Weight							
6 in.	100							
5 in.		90-100						
3 in.			90-100					100
1 1/2 in.		20-50	60-85					
1 1/4 in.				95-100				
1 in.					100			
3/4 in.			40-65	70-93	95-100			
3/8 in.				42-80	50-90			
No. 4			15-40	25-63	35-70	100 (2)	100 (2)	25-100
No. 10		0-10	10-30	16-48	15-55			
No. 40			5-20	8-28	10-35	75 (2)		
No. 100						15 (2)	30 (2)	
No. 200			2-12	2-12	5-15	8 (2)	15 (2)	15 (2)

**Notes:**

1. Reference: Wisconsin Department of Transportation *Standard Specifications for Highway and Structure Construction*.
2. Percentage applies to the material passing the No. 4 sieve, not the entire sample.
3. Per WisDOT specifications, both breaker run and select crushed material can include concrete that is 'substantially free of steel, building materials and other deleterious material'.

**Table 2  
Compaction Guidelines**

Area	Percent Compaction (1)	
	Clay/Silt	Sand/Gravel
<b><u>Within 10 ft of building lines</u></b>		
Footing bearing soils	93 - 95	95
Under floors, steps and walks		
- Lightly loaded floor slab	90	90
- Heavily loaded floor slab and thicker fill zones	92	95
<b><u>Beyond 10 ft of building lines</u></b>		
Under walks and pavements		
- Less than 2 ft below subgrade	92	95
- Greater than 2 ft below subgrade	90	90
Landscaping	85	90

**Notes:**

1. Based on Modified Proctor Dry Density (ASTM D 1557)

**APPENDIX E**

**ROCK EXCAVATION CONSIDERATIONS**



## **APPENDIX E**

### **ROCK EXCAVATION CONSIDERATIONS**

In order to minimize probable "rock" excavation expenses during construction, we suggest that project specifications incorporate the following:

- A. It is assumed that all excavations to levels and dimensions required by the Contract Documents are earth excavation. Earth excavation includes removal and disposal of all materials encountered except rock/sound bedrock which is defined as natural materials which:
  - 1. Cannot be excavated with a minimum 3/4 cubic yard capacity backhoe without drilling and blasting;
  - 2. Cannot be economically removed with a one-tooth ripper on a D8 cat (or equivalent);
  - 3. Requires the use of special equipment such as a pneumatic hammer;
  - 4. Requires the use of explosives (after obtaining written permission of the owner).
- B. Examples of material classified as rock are boulders 1/2 cubic yard or more in volume, bedrock, rock in ledges, and rock-hard cementitious aggregate deposits.
- C. Do not proceed with rock excavation work until architect, engineer and/or testing firm (i.e., CGC) has taken the necessary measures to determine quantity of rock excavation required to complete the work. Measurements will be taken after properly stripped of earth by the contractor. Contractor will be paid the difference between the cost of rock and earth excavation based on an agreed upon unit price established prior to starting rock excavation.

A statement should also be included in the specifications to the effect that: "Stated models of earth excavation equipment are merely for purposes of defining the various excavation categories and are not intended to indicate the brand or type of equipment that is to be used."

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## SECTION 01 11 00

### SUMMARY OF WORK

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Work Included in Contract Documents
  - 2. Contract Information
  - 3. Work Under Other Contracts
  - 4. Work Sequence
  - 5. Contractor Use of Premises
  - 6. Occupancy Requirements
  - 7. Products Ordered in Advance
  - 8. Owner Furnished Products
  - 9. Work Restrictions

##### 1.02 WORK INCLUDED IN CONTRACT DOCUMENTS

- A. Description of the Project:
  - 1. The project includes a new addition to the existing Unit Well 19 building to house treatment equipment for the removal of iron, manganese and radium.
  - 2. Site work includes grading, landscaping, driveway improvements and installation of a partially buried poured in place concrete backwash tank.
  - 3. On-site utility work includes a sanitary sewer line addition for the conveyance of backwash waste which will be conveyed via a metered force main to an air-break tank before gravity flowing to the UW-Madison sanitary sewer on Lake Mendota Drive. An existing sanitary lift station will be replaced and routed via air-break manhole to the UW-Madison sanitary sewer on lake Mendota Drive.
  - 4. Process work includes the installation of sixteen vertical pressure filters with pyrolusite media, gas chlorine chemical feed systems before and after filtration, two backwash reclaim pumps, two backwash waste pumps, two partially buried rectangular backwash reclaim tanks, controls, specialty valves, wellhead process piping, and connection to an existing ground storage reservoir. Process piping and water main ranges 4-inches to 12-inches in size.
  - 5. Structural and architectural work includes the construction of a one-floor building addition with chemical rooms, filter room, and a restroom.
  - 6. Alternate Bid #1 work includes a new roofing system on the existing Unit Well 19 concrete building, including but not limited to removals, roof recoating, insulation systems, and minor building demolition and windows.
  - 7. Mechanical and plumbing design includes a fire suppression system, domestic plumbing, backwash tank drains and a heating and ventilation system.
  - 8. Electrical design includes a motor control center, variable frequency drives for pump motors, domestic electrical, and circuits for automation and controls.
  - 9. New PLC and system controls.
  - 10. The site contains existing Unit Well 19 which must not be harmed by this project. The Contractor shall prevent all project-related incidences which interfere with the quality of the well and prevent any damage to the well. Contamination of Unit Well 19 due to plant contractor activities shall be remediated at the expense of the plant contractor.

##### 1.03 CONTRACT INFORMATION

- A. Type of Contract: Owner will award a Single Prime Contract.

- B. Scope of Contract:
  - 1. The Work to be done is shown on the Drawings and as specified in this document, the Project Manual entitled Unit Well 19 Treatment System Addition.
  - 2. This Contractor is solely responsible for the Work.

#### **1.04 WORK UNDER OTHER CONTRACTS**

- A. Other Work at Site:
  - 1. Owner reserves the right to let other separate contracts for Work of the Project, or to pursue other Work at the Site with its own personnel.
  - 2. Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract.
  - 3. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Work Not Included:
  - 1. Work not included is either marked "NIC," or "by others," on Drawings or is noted in each section of Specifications.
  - 2. Provide all labor and materials required unless so specifically noted or marked.
  - 3. Install Work indicated to be furnished by others or Owner unless specifically stipulated to be furnished and installed by others or Owner.
- C. All work in the public right-of-way shall be performed by a City licensed contractor. (MGO 16.23(9)(c)5) and MGO 23.01)

#### **1.05 CONSTRUCTION PERMITS**

- A. The Contractor shall obtain, keep current and pay all fees for any necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract limits and which will be occupied, encountered, used, or temporarily interrupted by the Contractor's operations unless otherwise stated.
- B. Record copies of all permits shall be furnished to the Engineer.

#### **1.06 WORK SEQUENCE**

- A. Construct Work in stages to accommodate Owner's requirements during the construction period. Coordinate construction schedule and operations with Owner and Engineer.
- B. See Section 01 12 16 Work Sequence for sequencing details.

#### **1.07 CONTRACTOR USE OF PREMISES**

- A. Confine operations at Site to areas permitted under contract or as directed by Engineer.
- B. Conform to site rules and regulations affecting Work while engaged in Project construction.
- C. Existing Structures:
  - 1. Keep existing driveways, playgrounds, and adjacent streets clear and available to public in accordance with Owner's or local authority's requirements.
  - 2. Maintain buildings in weathertight condition throughout the construction period.
  - 3. Protect building and occupants during construction period.
  - 4. Repair damages caused to existing public and private property and structures due to operations of Contractor to the satisfaction of, and at no additional cost to Owner.
  - 5. Take complete field measurements affecting all existing construction, wiring, piping, and equipment in this Contract, and assume responsibility for proper fit between Work and existing structures and other equipment.
- D. Construction personnel may park only in areas designated by the Owner.

- E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor air intakes.
- F. Damaged Property:
  - 1. Patch and/or clean existing improvements and restore damage of property on, or adjacent to Site occasioned by this Work, including, but not limited to, lawns, walks, curbs, pavements, roadways, structures, and utilities which are cut or damaged by operations and are not designated for removal, relocation, or replacement in the course of construction.
  - 2. All damaged site amenities including sidewalks, curb, driveway pavement along property frontage damaged during the course of construction shall be repaired or replaced as deemed necessary by the owner.
  - 3. Public Property or Utilities: Comply with laws, ordinances, rules, regulations, standards, orders of utility owner or any public authority having jurisdiction.
  - 4. Provide written acceptance of restoration work by authority or Owner.

#### **1.08 OCCUPANCY REQUIREMENTS**

- A. General Requirements:
  - 1. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
  - 2. Schedule the Work to accommodate this requirement.
  - 3. Coordinate activities which could cause interruption to Owner's activities.
  - 4. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.
- B. Owner Occupation During Construction:
  - 1. Owner will occupy Site during the Work.
- C. Owner Occupancy of Completed Areas of Construction:
  - 1. Owner reserves the right to place and install equipment as necessary in completed areas of the facilities and to occupy such completed areas prior to Substantial Completion in accordance with the Supplementary Conditions. Such use shall not constitute acceptance of such portions of the Work or relieve the Contractor of any obligations except for improper use or damage caused by employees or agents of Owner.
  - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
  - 3. Mechanical and electrical systems shall be fully operational and required tests and inspection successfully completed.
  - 4. On beneficial occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of building.
  - 5. On beneficial occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building.

#### **1.09 PRODUCTS ORDERED IN ADVANCE**

- A. Storage:
  - 1. Products will be allowed to be stored at the Site prior to commencement of construction activities.
  - 2. Contractor shall store such items as directed by Owner.

#### **1.10 OWNER FURNISHED PRODUCTS**

- A. Items furnished by Owner will be identified in the Specification sections.
- B. Owner's Responsibilities:
  - 1. Arrange for, and deliver Owner reviewed Shop Drawings, Product Data and samples to Contractor.
  - 2. Arrange and pay for product delivery to Site.
  - 3. At time of delivery, inspect products jointly with Contractor.
  - 4. Submit claims for transportation damage and replace damaged, defective or deficient items.
  - 5. Arrange for manufacturer's warranties, inspections and service.

- C. Contractor's Responsibilities:
  - 1. Review Owner reviewed Shop Drawings, Product Data and samples.
  - 2. Receive and unload products at Site; inspect for completeness or damage, jointly with Owner.
  - 3. Provide support systems to receive Owner's equipment.
  - 4. Protect Owner-furnished items from damage during storage and handling, including damage from exposure to the elements.
  - 5. Install and otherwise incorporate Owner-furnished items into the Work.
  - 6. Repair or replace items damaged after receipt, except that damage caused by Owner's employees or agents.

### **1.11 WORK RESTRICTIONS**

- A. On-Site Work Hours:
  - 1. Normal business working hours of 7:00 a.m. to 7:00 p.m. Monday through Saturday.
  - 2. Sunday Work: only with prior permission from Engineer: 10:00 a.m.-7:00 p.m.
  - 3. Legal Holidays: Defined in General Conditions.
  - 4. Hours for Utility Shutdowns: 7 am to 3 pm Monday through Friday.
  - 5. Hours for Core Drilling or Noisy Activity: 7 am to 7 pm.
- B. Existing Utility Interruption:
  - 1. Do not interrupt utilities serving facilities occupied by Owner or others without written permission by Owner.
  - 2. Notify Owner not less than 2 days in advance of proposed utility interruptions.

### **1.12 SUBSURFACE DATA**

- A. Subsurface data are offered in good faith solely for placing the Bidder in receipt of all information available to the Owner and Engineer and in no event is to be considered as part of the Contract Documents.
- B. The Bidder must interpret such subsurface data according to his own judgment and acknowledge that he is not relying upon the same as accurately describing the subsurface conditions, which may be found to exist.
  - 1. The test boring logs present factual information of the subsurface conditions at the specific test boring location only. The Bidder should not consider, or conclude, that the subsurface conditions will be consistent between test boring locations.
- C. The Bidder further acknowledges that he assumes all risks contingent upon the nature of the subsurface conditions to be actually encountered by him in performing the work covered by the Contract, even though such actual conditions may result in the Bidder performing more or less work than he originally anticipated.
- D. The Bidder is further advised that the Owner has made sub-surface investigations and a report has been prepared, in connection with this project for the Engineer, a copy of which is included in the Project Manual.
- E. In making this data available, the Owner makes no guarantee, either expressed or implied, as to their accuracy or to the accuracy of any interpretation thereof.

### **1.13 FIRST AID FACILITIES AND ACCIDENTS**

- A. First Aid Facilities:
  - 1. The Contractor shall provide at the Site such equipment and facilities as are necessary to supply first aid to any of his personnel who may be injured in connection with the Work.
- B. Accidents:
  - 1. The Contractor shall promptly report, in writing, to the Engineer and Owner all accidents whatsoever out of, or in connection with, the performance of the Work, whether on or adjacent to

the Site, which cause death, personal injury or property damage, giving full details and statements of witnesses.

2. If death, serious injuries, or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Owner and the Engineer.
3. If any claim is made by anyone against the Contractor or a subcontractor on account of any accidents, the Contractor shall promptly report the facts, in writing, to the Engineer and Owner, giving full details of the claim.

#### **1.14 PERIODIC CLEANUP: BASIC SITE RESTORATION**

- A. During construction, the Contractor shall regularly remove from the Site of the Work all accumulated debris and surplus materials of any kind which result from his operations. Unused equipment and tools shall be stored at the Contractor's yard or base of operations for the Project.
- B. The Contractor shall perform the cleanup work on a regular basis and as frequently as ordered by the Engineer. Basic site restoration in a particular area shall be accomplished immediately following the installation or completion of the required facilities in that area. Furthermore, such work shall also be accomplished, when ordered by the Engineer, if partially completed facilities must remain incomplete for some time period due to unforeseen circumstances.
- C. Upon failure of the Contractor to perform periodic cleanup and basic restoration of the Site to the Engineer's satisfaction, the Owner may, upon five (5) days prior written notice to the Contractor, without prejudice to any other rights or remedies of the Owner, cause such work for which the Contractor is responsible to be accomplished to the extent deemed necessary by the Engineer, and all costs resulting therefrom shall be charged to the Contractor and deducted from the amounts of money that may be due him.

#### **1.15 CONSTRUCTION VIDEO AND PHOTOGRAPHS**

- A. The Contractor shall provide all labor, materials, equipment, and services to furnish the Owner and Engineer a color pre-construction video of the existing conditions for the entire Project Site (entire limits of disturbance). The video shall be supplemented with digital photographs of all areas. All photos and videos shall be date stamped. Video footage shall be conducted at a slow pace for clarity and have adequate contemporaneous audio to accompany the footage with a clear description of the locations shown in the video, names of streets and buildings, and identification of defects, etc. The original video image and photographs shall be turned over to the Engineer prior to beginning construction activities. The video shall be provided as an Audio Video Interleave File (.avi) and shall be provided on a USB jump drive. The video shall clearly identify existing site and structural conditions prior to construction.
- B. Scope of coverage for video and photos shall include all adjacent surface features, including but not limited to: storage areas, all concrete and asphalt pavements, curbs and gutter, storm drains, fencing, structures to be demolished, ditches, gates, culverts, sidewalks, retaining walls, building exteriors, trees, pavement markings, electrical and other utility features. All existing cracks and fractures shall be documented.
- C. For areas that require clearing and grubbing, Contractor shall also provide a post-clearing video and photographs for that portion of the Work once clearing and grubbing is completed.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

Not Used

**END OF SECTION**

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## SECTION 01 12 16

### WORK SEQUENCE

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. General identification of Work sequence.
- B. Related Sections:
  - 1. Section 01 11 00 - Summary of Work
  - 2. Section 01 31 13 - Coordination
  - 3. Section 01 33 00 - Submittal Procedures
  - 4. Section 02 41 13 - Building Removal
  - 5. Section 33 11 00 - Water Distribution Systems
  - 6. Section 40 23 10 - Process Water and Waste Piping

##### 1.02 QUALITY ASSURANCE

- A. Coordinate all equipment shutdowns, startups, and general scheduling with Owner.

##### 1.03 SUBMITTALS

- A. Conform to Section 01 33 00.
- B. Work Plans:
  - 1. Work plans and schedules shall be submitted for all work activities involving temporary shutdown of the Owner's water treatment plants, potable water storage facilities, or existing pump stations.
  - 2. Work plans and schedules shall be submitted for all temporary and permanent process systems, electrical and control systems requiring testing and/or commissioning prior to system start-up and integration into the Owner's existing systems and/or operations.
  - 3. Excavation and shoring work plans.
  - 4. Piping Systems:
    - a. Plan and schedule for all pipeline work requiring connections to the Owner's existing pipeline systems.
    - b. Detailed piping connection layouts for connection to existing and proposed pipe and equipment.
    - c. Plan for Disinfection Procedures
    - d. Plan for Flushing Operations
    - e. Plan for Hydrostatic Testing Procedures
  - 5. Others as required by the Owner and/or specified elsewhere.

#### PART 2 PRODUCTS

Not Used

#### PART 3 EXECUTION

##### 3.01 GENERAL

- A. Construct Work in phases to allow for Owner's continuous occupancy as required for operation of the existing Unit Well 19, Reservoir, and Booster Pumps 1, 2, and 3. Coordinate construction schedule and operations with Owner and Engineer.

- B. All utility interruptions to the Owner's system shall occur at off-peak hours of operation and at other such times as suitable to the Owner. Contractor shall assume that these interruption periods will occur on evenings and overnight.
- C. Contractor shall request a shut down for connection of new equipment and piping to the existing system no less than 14 days prior to requested date of shutdown.
  - 1. A request shall be specific for the scope of work to be performed and at a minimum shall include the following information:
    - a. Date and time of requested shutdown.
    - b. Work to be performed.
    - c. Existing equipment or piping to be removed from service to accommodate the shutdown.
    - d. Duration of shutdown requested/anticipated duration of work.
  - 2. Shutdowns to connect new equipment or piping to existing will not be permitted on Friday, Saturdays, or Sundays.
- D. Determine type and extent of temporary facilities the Project requires to maintain continuous operation.
- E. Provide all temporary connections, parallel temporary lines, temporary power, temporary bulkheads, temporary equipment, and temporary operations necessary to perform Work.
- F. The Owner may disallow any impacts to system or facility operations due to expected, and/or unexpected system demands. In the event that the Owner has to cancel a planned shutdown, the Contractor shall work with the Owner to reschedule the shutdown at a mutually convenient time. No additional compensation shall be allowed due to the cancellation of a previously scheduled utility or system shutdown.
- G. Submit a detailed Phasing Schedule in accordance with Section 01 33 00. Schedule to include:
  - 1. Proposed phasing for the Project.
  - 2. Construction dates for each component of Work identified in each phase.
  - 3. Description of Work sequence.
  - 4. Description of interaction with existing plant facilities.
  - 5. Temporary pumping, piping, and utility services to maintain operability for facilities.
  - 6. A plan of action for each impact to normal operations of the system. A plan of action shall include:
    - a. Description of the work impacting normal operations.
    - b. Outline of procedure to minimize the amount of time normal operations will be impacted.
    - c. Description of potential issues that could arise and how to avoid/correct these issues.
    - d. Must be approved by Owner.
  - 7. Resubmit until approved by Engineer.
- H. Review existing facilities with Owner to become familiar with potentially difficult items that must remain in service. No Work procedures will be permitted that require shutting down of any portion of existing facilities, except as authorized by Owner.

### **3.02 SEQUENCING REQUIREMENTS**

- A. Construction sequencing of the water main and pump station are subject to Contractor's means and methods. Contractor shall clearly identify work sequence on Construction Schedules
- B. New piping and equipment will not be permitted to be connected to the existing system until flushing and disinfection requirements have been met.
- C. The following is a list of sequencing requirements. This is not intended to be exhaustive, nor does it relieve the contractor of any responsibility in developing or implementing a Phasing Schedule.
  - 1. Work will be permitted on the site beginning March 1, 2024

2. Contractor shall mow and prepare the staging area prior to April 15, 2024. If the staging area is not mowed and prepared prior to April 15, 2024, the area will not be permitted for use until October 15, 2024.
3. The well house, chemical feed systems, reservoir, and booster pumps shall be in service during high demand months, defined as May 1 to October 15. This period may change at the sole discretion of the Owner/Engineer based on system demands.
4. The reservoir and booster pumps shall be in service during low demand months, defined as October 16 to April 30.

**END OF SECTION**

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## SECTION 01 25 13

### PRODUCT SUBSTITUTION PROCEDURES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Administrative and procedural requirements for handling requests for substitutions.
- B. The following is not included in this Section:
  - 1. Procedural requirements governing Contractor's selection of product options (Section 01 60 00).

##### 1.02 DEFINITIONS

- A. Definitions used in this Article are not intended to change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Requests for changes in products, materials, equipment and methods of construction required by Contract Documents proposed by Contractor.
- C. The following are not considered substitutions:
  - 1. Revisions to Contract Documents requested by Owner or Engineer.
  - 2. Specified options of products and construction methods included in Contract Documents.
  - 3. Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

##### 1.03 SUBMITTALS

- A. Substitution Request Prior to Bid: For a Product Substitution to be considered, the following conditions must be met:
  - 1. All requests must be submitted in writing no later than 10 calendar days prior to the date for receipt of the bids.
  - 2. Submit each request for substitution (one material or product per form) on the attached "Substitution Request Form" attached at the end of this section (either duplicated from the Project Manual or available from Engineer's office) together with a self-addressed, stamped envelope. Submittals not accompanied by this form properly filled in and endorsed will be discarded without review. NO EXCEPTIONS.
  - 3. Identify any impact of the substituted product on related items.
  - 4. Approved items will be listed in addenda. Requests for substitution will be returned in the self-addressed, stamped envelope provided by bidder at Engineer's earliest convenience.
- B. All substitutions permitted on addenda must meet or exceed requirements of the specifications including, but not limited to:
  - 1. Warranty.
- C. Substitution Request After Bid: Requests for substitution will be considered if received within 60 days after commencement of the work. Requests received more than 60 days after commencement of the work may be considered or rejected at the discretion of Engineer.
  - 1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required for change order proposals.
  - 2. Identify the product, or the fabrication or installation method to be replaced in each request. Include related specification section and Drawing numbers.
  - 3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    - a. Product data, including drawings and descriptions of products, fabrication and installation procedures.

- b. Samples, where applicable or requested.
  - c. A detailed comparison of significant qualities of the proposed substitution with those of the work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
  - d. Coordination information, including a list of changes or modifications needed to other parts of the work and to construction performed by Owner and separate contractors, that will become necessary to accommodate the proposed substitution.
  - e. A statement indicating the substitution's effect on Contractor's construction schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall contract time.
  - f. Cost information, including a proposal of the net change, if any in the contract sum.
  - g. Certification by Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated.
  - h. Include Contractor's waiver of rights to additional payment or time, which may subsequently become necessary because of the failure of the substitution to perform adequately.
- D. Substitution Conditions:
- 1. Contractor's substitution request will be received and considered by Engineer when one or more of the following conditions are satisfied, as determined by Engineer, otherwise requests will be returned without action except to record noncompliance with these requirements:
    - a. Extensive revisions to Contract Documents are not required.
    - b. Proposed changes are in keeping with the general intent of Contract Documents.
    - c. The request is timely, fully documented and properly submitted.
    - d. Contractors and suppliers will be expected to provide the specified product unless prior approval is received from Engineer's office in sufficient time so that all bidders can be notified through an addendum.
    - e. The specified product or method of construction cannot be provided within the contract time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the work promptly or coordinate activities properly.
    - f. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
    - g. A substantial advantage is offered to Owner, in terms of cost, time, energy conservation, or other considerations of merit, after deducting offsetting responsibilities Owner may be required to bear. Additional responsibilities for Owner may include additional compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, or separate contractors, and similar considerations.
    - h. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where Contractor certifies that the substitution will overcome the incompatibility.
    - i. The specified product or method of construction cannot be coordinated with other materials, and where Contractor certifies that the proposed substitution can be coordinated.
    - j. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where Contractor certifies that the proposed substitution provides the required warranty.
    - k. Where a proposed substitution involves more than one prime contractor, each contractor shall cooperate with the other contractors involved to coordinate the work, provide uniformity and consistency, and to assure compatibility of products.
- E. Limitations: Contractor's submittal and Engineer's acceptance of Shop Drawings, Product Data, or Samples that relate to construction activities not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.
- F. Substitution Causing Redesign: Engineer time for redesign as a result of substitution, will be charged to Owner, then deducted by Construction Change Directive from Contract Amount.
- G. Engineer's Action:
- 1. Request Prior to Bid: If approved, substitution will be included in an addendum.

2. Request After Bid:
  - a. If necessary, within one week of receipt of the request for substitution, Engineer will request additional information or documentation necessary for evaluation of the request.
  - b. Within two weeks of receipt of the request, or one week of receipt of the additional information or documentation, whichever is later, Engineer will notify Contractor of acceptance or rejection of the proposed substitution.
  - c. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name.
  - d. Acceptance will be in the form of a change order.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SUBSTITUTION REQUEST FORM**

TO: Attn: Jeff Nussbaum  
 Short Elliott Hendrickson Inc.  
 10 N. Bridge Street  
 Chippewa Falls, WI 54729  
 715.720.6200

PROJECT: Madison Water Utility - Well No. 19 Treatment System Addition

SECTION NO.	ARTICLE NO.	SPECIFIED PRODUCT	PROPOSED SUBSTITUTION
-------------	-------------	-------------------	-----------------------

- A. Does the substitution affect dimensions shown on Drawings?      Yes       No
- B. Does the substitution affect other trades?      Yes       No
- C. Does the manufacturer's guarantee differ from that specified?      Yes       No
- D. If you indicated "Yes" to Items A, B, or C above, attach a thorough explanation on your company letterhead.

E. If there are other differences between proposed substitution and specified product, attach a thorough explanation on your company letterhead. If differences are not noted and acknowledged in writing by Engineer, product must comply with specification requirements.

F. The proposed substitution was used within the last 24 months on the following project:

Project Name \_\_\_\_\_  
 Location \_\_\_\_\_  
 Engineer \_\_\_\_\_  
 Telephone No. \_\_\_\_\_

- G. Has the proposed substitution been used on an SEH project within the last 12 months?    Yes     No
- If yes, which project? \_\_\_\_\_

**All questions must be answered. Incomplete forms will not be reviewed.  
 Include a self-addressed, stamped envelope for reply.**

Submitted By: \_\_\_\_\_

\_\_\_\_\_  
 Signature

\_\_\_\_\_  
 Firm

\_\_\_\_\_  
 Address

\_\_\_\_\_  
 Date

\_\_\_\_\_  
 Phone

\_\_\_\_\_  
 E-mail

For Use by Design Consultant	
<input type="checkbox"/>	Not Accepted, Not Enough Information
<input type="checkbox"/>	Not Accepted, Does Not Appear to be Equal
<input type="checkbox"/>	Accepted <input type="checkbox"/> Accepted as Noted
<input type="checkbox"/>	Received Too Late
By _____	
Date _____	
Remarks _____	
_____	
_____	



## SECTION 01 29 10

### APPLICATIONS FOR PAYMENT

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Procedures for Administration of Applications for Payment:
  - 1. Schedule of Values:
    - a. Coordination.
    - b. Format and Content.
    - c. Breakdown Detail.
    - d. Schedule Updating.
  - 2. Application for Payment:
    - a. Coordination.
    - b. Format.
    - c. Typical Application.
  - 3. Additional Requirements:
    - a. Initial Application.
    - b. Substantial Completion.
    - c. Final Payment.
  
- B. Related Sections:
  - 1. Section 01 33 00 - Submittal Procedures
  - 2. Section 01 77 00 - Closeout Procedures

##### 1.02 SCHEDULE OF VALUES

- A. At the Preconstruction Conference, the Engineer will provide the Contractor with a basic Excel® spreadsheet document containing the breakdown items, as listed in Paragraph D, for the Contractor's use in preparing the cost breakdown schedule. Following the breakdown list is mandatory.
  
- B. Format and Content:
  - 1. Include following Project identification on Schedule of Values:
    - a. Project name and location.
    - b. Name of Engineer.
    - c. Engineer's Project number.
    - d. Contractor's name and address.
    - e. Date of submittal.
  - 2. Use Bid Form as a guide to establish the major items of Work. Further break down of major Work items can be accomplished by using Project Manual Table of Contents as guide to establish format for Schedule of Values.
  - 3. Arrange Schedule of Values in tabular form with separate columns to indicate following for each item listed:
    - a. Generic name.
    - b. Related specification Section.
    - c. Name of subcontractor, if any.
    - d. Name of manufacturer or fabricator.
    - e. Name of supplier.
    - f. Change Orders (numbers) that affect value.
    - g. Dollar value.
    - h. Round amounts to nearest whole cent; total to equal Contract Sum.
    - i. Percentage of Contract Sum to nearest 1 percent, adjusted to total 100 percent.

- C. Project Cost Breakdown:
1. Provide breakdown of Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports.
  2. Submit 1 preliminary copy of progress payment application for review Submit Schedule of Values in duplicate to Engineer within 10 days after date of Owner-Contractor Agreement.
  3. The format guideline for the cash flow break down for the payment application shall be as described below. The breakdown shall be submitted to the Engineer on standard Excel® spread sheet software and shall serve as the basis for the monthly payment request submittals.
- D. Breakdown Detail:
1. Cost Breakdown of Contract Amounts:
    - a. Upon completion of the initial construction schedule, the Contractor shall, within 10 working days of the Notice of Award, establish a dollar value for each cost-related activity identified in the following cash flow break down.
    - b. The breakdown is intended to include key elements of the work from each Specification Section. In many cases, multiple entries are necessary for each Section. The format guideline for the cash flow break down for the payment application shall be as described below.
    - c. Dollar values shall Total Contract Amount and breakdown shall, at a minimum, follow the line items identified in the following list. Unit prices will be broken down as prepared in the Bid Form.
  2. The Project shall be broken down by work item into the four phases described in the Summary of Work.
  3. Breakdown of Contract dollar amounts shall, at a minimum, include the following work items for each phase of Work described in the Summary of Work:

Insurance	Asphalt Concrete Pavement (L&M)
Bonds	Porous Pavement (L&M)
Mobilization	Concrete Curbing (L&M)
Demobilization	Turf Restoration (L&M)
Supervision	Exterior Plants (L&M)
Safety	Sanitary Sewer Manhole (L&M)
Layout/Surveying	Meter Manhole (L&M)
Testing	Air Break Manhole (L&M)
Temporary Facilities	Meter Manhole (L&M)
Project Sign	Below grade backwash waste piping
Weekly Cleanup (Labor)	Below grade SS pipe
Weekly Cleanup (Material)	Cast-in-Place Concrete (L) – Backwash Tank
Final Facility Cleaning (L & M)	Cast-in-Place Concrete (M) – Backwash Tank
Final System Startup	Cast-in-Place Concrete (L) – Building Foundation
Warranties	Cast-in-Place Concrete (M) – Building Foundation
Facility Record Documents	Cast-in-Place Concrete (L) - Building Base Slab
Site Demolition (L&M)	Cast-in-Place Concrete (M) - Building Base Slab
Selective Building Demolition	Precast Concrete Wall Panels (L&M)
Erosion and Sediment Control (L&M)	Precast Roof Plank (L&M)
Site Grading (L & M)	CMU Walls
Excavation and Embankment (L & M)	Sidewalks (L & M)
Structure Excavations and Backfills (L & M)	Concrete and Masonry Sealer (L)
Trench Excavation and Backfill (L & M)	Concrete and Masonry Sealer (M)
Stormwater Management (L & M)	Cold-Formed Metal Framing (L&M)
Structural Shoring (L & M)	Metal Fabrication (L&M)

Misc. Metals (L&M)  
 Rough Carpentry (L&M)  
 Ladders  
 Bituminous Dampproofing (L&M)  
 Cementitious Waterproofing (L&M)  
 Thermal Insulation (L&M)  
 Firestopping (L&M)  
 Roof Accessories (L & M)  
 Roof Hatches - WTP & BW Tank (L&M)  
 TPO Membrane Roofing System (L&M)  
 EPDM Membrane Roofing System (L&M)  
 Joint Sealers (L & M)  
 Doors and Frames (L&M)  
 Overhead Coiling Door (L&M)  
 Finish Carpentry (L)  
 Finish Carpentry (M)  
 Finish Hardware (L & M)  
 Laboratory Casework (L&M)  
 Fume Hood (L&M)  
 Painting, Walls and Floor (L)  
 Painting, Walls and Floor (M)  
 Painting, Process Equipment and Pipe (L)  
 Painting, Process Equipment and Pipe (M)  
 Alternate No. 1 - Roofing Improvements  
 Plumbing Piping Insulation (L&M)  
 Domestic Water Piping and Valves (L&M)  
 Sanitary Waste and Vent Piping (L&M)  
 Fire Protection System  
 Hangers and Supports for HVAC Piping and Equipment (L&M)  
 Gas Fired Unit Heaters (L&M)  
 Electric Unit Heaters (L&M)  
 Portable Dehumidifiers  
 Motorized Louvers (L&M)  
 Exhaust Fans and Ductwork  
 Electrical Demolition  
 Low-Voltage Electrical Power Conductors & Cables (L&M)

Control-Voltage Electrical Power Cables (L&M)  
 Grounding and Bonding (L&M)  
 Hangers & Supports for Electrical Systems (L&M)  
 Raceways & Boxes for Electrical Systems (L&M)  
 Motor Control Center (L)  
 Motor Control Center (M)  
 Lighting – Interior  
 Lighting - Exterior  
 Enclosed Switches & Circuit Breakers  
 Variable Frequency Drives  
 Wiring Devices  
 Fire Alarm System  
 Supervisory Control Panel (L)  
 Supervisory Control Panel (M)  
 Stormwater – Grading and Level Spreader(L)  
 Stormwater – Grading and Level Spreader (M)  
 Process Piping Hangers and Supports (L&M)  
 Control for Process Systems (L&M)  
 Fire Hydrant, 6” DIP, and Valve (L&M)  
 Process Pipe/Fittings (L)  
 Process Pipe/Fittings (M)  
 Process Valves and Accessories (L)  
 Process Valves and Accessories (M)  
 Horizontal Centrifugal Pumps (L&M)  
 Horizontal Centrifugal Pumps Startup  
 Non-Clog Submersible Pumps (L&M)  
 Non-Clog Submersible Pumps Startup  
 Analyzers (L&M)  
 Analyzer Startup  
 Sodium Hypochlorite Feed System (L&M)  
 Sodium Hypochlorite Feed System Startup  
 Fluoride Feed System (L&M)  
 Fluoride Feed System Startup  
 Vertical Pressure Filter System (L)  
 Vertical Pressure Filter System (M)  
 Vertical Pressure Filter System Startup

- E. Schedule Updating: Update and resubmit Schedule of Values when Change Orders or Work Change Directives result in change in Contract Sum.

### 1.03 APPLICATIONS FOR PAYMENT

- A. Coordination: Each application for payment shall be consistent with previous applications and payments as certified by Engineer and paid by Owner.
- B. Application for Payment Forms: Included in the Contract Documents.

- C. Typical Application:
  - 1. Payment Application Times: Each progress payment date is indicated in either the Supplementary Conditions or the Agreement.
  - 2. Period of Work Covered: Length of time for construction Work covered by each Application for Payment is indicated in the Agreement.
  - 3. Preparation:
    - a. Complete every entry on form, including notarization and execution by person authorized to sign legal documents on behalf of Contractor.
    - b. Incomplete applications will be returned without action.
    - c. Entries must include data on Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions have been made. Updated Contractor's Construction Schedule shall be submitted with every Application for Payment.
    - d. Include amounts of Change Orders and Work Change Directives issued prior to last day of construction period covered by application.
  - 4. Transmittal: Submit 5 executed copies of each Application for Payment to Engineer by means ensuring timely receipt. Electronic copies may be acceptable if approved by the Engineer and Owner.
- D. Submit updated Construction Schedule with each Application for Payment. Engineer will not review Application for Payment without a revised schedule.
- E. Attach the following supporting documentation, in addition to the requirements of General Conditions Article 14 to each play application:
  - 1. Documentation to substantiate Bid Unit Price work (If applicable).
  - 2. Updated construction schedule consistent with Section 01 33 00 and Section 01 26 00. Payment will not be made until the updated schedule is received.
  - 3. Evidence that all trades are maintaining up to date record drawings.
  - 4. Copies of all invoices from suppliers and vendors for materials and equipment installed in the water treatment plant showing all associated state sales taxes. Upon acceptable review, Owner will either reimburse the Contractor for the invoices as described in the Agency Agreement or pay them directly. The total requested sum on each Application for Payment shall be inclusive of all invoices submitted with said Application for Payment.
  - 5. Dollar values of cost-related activities shall be updated as the construction schedule is updated, as described above, to show an accurate dollar value completed during progression of the Work.
- F. Payment for equipment and materials delivered but not yet installed, will be made if such items are stored on the Site and protected from vandalism, theft, and the elements. Payments shall be for the actual proved cost of the item and all such items shall be covered by the Contractor's insurance.
- G. Requests for payment for such equipment and materials shall be accompanied with appropriate vouchers, such as copied billing and delivery receipts, stating the item, the project, and the responsible contractor. Such requests shall also include evidence of insurance for the stored items.

#### **1.04 ADDITIONAL REQUIREMENTS**

- A. Initial Application for Payment:
  - 1. Coordinate submittals as required by Section 01 33 00.
  - 2. Applications for Payment will not be considered if copies of required submittals have not been received by Engineer.
- B. Substantial Completion:
  - 1. Coordinate submittals as required by Sections 01 33 00 and 01 77 00.
  - 2. Administrative actions which must precede submittal of Substantial Completion Application for Payment include:
    - a. Change of door locks to Owner's access.
    - b. Start-up, training, adjusting, and approved Operation & Maintenance Manuals.
  - 3. Following issuance of Certificate of Substantial Completion, submit Application for Payment.
  - 4. Applications for Payment will not be considered if copies of required submittals have not been received by Engineer.

- C. Final Payment Application:
1. Coordinate submittals as required by Sections 01 33 00 and 01 77 00.
  2. Administrative actions which must precede submittal of final Application for Payment include:
    - a. Completion of Project requirements.
    - b. Completion of items specified for completion after Substantial Completion.
    - c. Assurance that unsettled claims will be settled.
    - d. Assurance that Work not complete and accepted will be completed without undue delay.
    - e. Removal of temporary facilities and services.
    - f. Removal of surplus materials, rubbish, similar elements.
    - g. Final cleaning.
    - h. Submittal of all warranty information and O&M manuals.
    - i. All other requirements outlined in the General and Supplemental General Conditions.
  3. Applications for Payment will not be considered if copies of required submittals have not been received by Engineer.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

Not Used

**END OF SECTION**

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## SECTION 01 31 13

### COORDINATION

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Project Coordination
  - 2. Job Site Administration

##### 1.02 COORDINATION BY GENERAL CONTRACTOR

- A. Coordinate use of premises under direction of Owner.
- B. Coordinate scheduling, submittals, and Work to ensure efficient and orderly sequence of installation.
  - 1. Coordinate activities for mutual benefit and cooperate to facilitate the general progress of the Work.
  - 2. Each subcontractor shall be thoroughly familiar with all provisions governing the Work of other contractors, and shall obtain from such contractors all information as may be required to coordinate Work with theirs.
  - 3. Each trade shall perform its Work in proper sequence and arrangement in relation to other activities and shall join his Work to that of others in accordance with the intent of the Drawings and specifications.
  - 4. Each trade shall give due notice and proper information for any special provisions necessary in the placing or setting of Work that may come in contact with Work of other contractors.
- C. Inspect the Contract Documents for Work of others that is inter-related, and afford other trades every reasonable opportunity for the installation of their Work. Coordinate Work of various specification sections having interdependent responsibilities.
- D. Prepare coordination drawings where off-site fabricated products and materials are by separate entities and must accurately interface. Coordination drawings shall indicate how Work, shown by separate Shop Drawings, will interface and shall indicate sequence for installation.
- E. Coordinate space requirements and installation of mechanical and electrical Work.
  - 1. Follow routing shown for pipes, ducts, and conduit as closely as practicable; place runs parallel with line of building.
  - 2. Utilize space efficiently to maximize accessibility for other installations, maintenance, and repairs.
  - 3. Conceal pipes, ducts, and wiring within the construction in finished areas, except as otherwise indicated.
  - 4. Coordinate locations of fixtures and outlets with finish elements.
  - 5. All final decisions as to the right-of-way and run of interfering pipes, ducts, etc., shall be made by Engineer at Project meetings.

##### 1.03 JOB SITE ADMINISTRATION

- A. Supervise and direct the Work. Employ and maintain a full time, qualified supervisor or superintendent to act as Contractor's representative at the Site.
- B. Enforce good order and conduct among contractors, installers, and construction employees.
- C. Require installers to inspect conditions under which Work is to be performed. Installer shall report all unsatisfactory conditions in writing to Contractor. Do not proceed with Work until unsatisfactory conditions have been corrected.

- D. Where installations include manufactured products, comply with manufacturer's applicable instructions and recommendations for installation to the extent that these instructions and recommendations are more explicit or more stringent than requirements indicated in the Contract Documents. Where manufacturer provides contradictory instructions, notify Engineer immediately and request clarifications.
- E. Recheck measurements and dimensions of the Work, as an integral step of starting each installation.
- F. Coordinate enclosure of Work with required inspections and tests, so as to minimize necessity of uncovering Work for that purpose.
- G. Where mounting heights are not indicated, mount individual units of work at industry recognized standard mounting heights for the particular application indicated. Refer questionable mounting height choices to Engineer.
- H. Supervise performance of the Work to ensure that none of the Work, whether completed or in progress, will be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- I. Clean and perform maintenance as frequently as necessary throughout construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Coordinate completion and clean up of Work.

**1.04 SUBMITTALS**

- A. Provide listing of Contractor's principal staff assignments and consultants, including name, home and work addresses, and telephone numbers.
- B. Provide supervisor's or superintendent's name, home and work address, and telephone numbers.
- C. Provide names, work address, telephone numbers, samples of signature, and limits of authority of each individual authorized to sign change orders, field modifications, and monthly pay requests for Contractor.

**1.05 FIELD CONDITIONS**

- A. Before ordering material or commencing Work, check and verify all dimensions and conditions. Notify Engineer of any omissions or discrepancies immediately.
- B. Field measurements shall be furnished in a timely manner to suppliers and fabricators who require them to complete their Work. Ascertain the requirement for such measurements at the earliest practical date and make every reasonable effort to expedite the affected Work.
- C. Conflicts: Engineer has exercised reasonable professional care to ensure there are no conflicts between the Work of the various trades. Such conflicts, however, may exist and no warranty to the contrary is made or implied.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**



**SECTION 01 31 19**  
**PROJECT MEETINGS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Procedures for Administration of Project Meetings:
  - 1. Preconstruction Conference
  - 2. Progress Meetings
  - 3. Preinstallation Conferences
  
- B. Related Sections:
  - 1. Section 01 31 13 - Coordination
  - 2. Section 01 33 00 - Submittal Procedures

**1.02 PRECONSTRUCTION/SITE MOBILIZATION CONFERENCE**

- A. Scheduled by Owner or Engineer after Notice of Award, prior to commencement of construction for:
  - 1. Execution of Owner-Contractor Agreement and exchange of preliminary submittals if not previously completed.
  - 2. Clarification of Owner and Contractor responsibilities in use of the Site and review of administrative procedures.
  
- B. Attendees: Owner, Engineer, Consultants, Contractors, major subcontractors, other concerned parties represented by persons familiar with and authorized to conclude matters relating to Work.
  
- C. Agenda:
  - 1. Items of significance that could affect progress including, but not limited to:
    - a. Submittal of executed bonds and insurance certificates.
    - b. Execution of Owner-Contractor Agreement if not previously completed.
    - c. Distribution of Contract Documents.
    - d. Use of premises by Owner and Contractor:
      - 1) Owner's requirements and occupancy.
      - 2) Construction facilities provided by Owner (if any).
      - 3) Temporary utilities provided by Owner (if any).
      - 4) Use of premises office, work, and storage areas.
    - e. Security and housekeeping procedures.
    - f. Submittals:
      - 1) Final list of subcontractors, suppliers, products.
      - 2) Schedule of Values.
      - 3) Progress Schedule.
      - 4) Designation of responsible personnel:
        - a) Contractor's principal staff and consultants.
        - b) Contractor's superintendent or job foreman acting as Contractor's Site representative.
        - c) Owner's and Contractor's designated individuals authorized to sign Change Orders, field modifications, and monthly pay requests.
    - g. Procedures for processing:
      - 1) Field decisions.
      - 2) Submittals:
        - a) Shop Drawings.
        - b) Product Data.
        - c) Samples.
      - 3) Substitutions.
      - 4) Applications for Payments.

- 5) Proposal requests.
- 6) Change Orders.
- 7) Contract Closeout.
- h. Schedules:
  - 1) Tentative construction schedule.
  - 2) Critical Work sequencing.
  - 3) Progress meetings.
- i. Procedures for testing.
- j. Procedures for maintaining Record Documents.
- k. Requirements for startup of equipment: Inspection and acceptance of equipment put into service during construction period.
- l. Equipment deliveries and priorities.
- m. Contractor responsibilities:
  - 1) Safety procedures.
  - 2) First aid.

### 1.03 PROGRESS MEETINGS

- A. Contractor:
  - 1. Attend monthly meetings and coordinate attendance of subcontractors and suppliers as necessitated by the work or requested by the Engineer.
    - a. During startup procedures on equipment and plant, weekly meetings may be required to coordinate work items.
  - 2. Make physical arrangements, for each progress meeting. Contractor shall provide a meeting table and chairs for each attendee.
- B. Attendees:
  - 1. Contractor, job superintendent, subcontractors and suppliers, other entity concerned with current progress or involved in planning, coordination or performance of future activities; Owner, Engineer, professional consultants as appropriate to agenda.
  - 2. Attendees shall be familiar with Project and authorized to conclude matters relating to progress.
- C. Agenda:
  - 1. Items of significance that could affect progress, including topics for discussion as appropriate to current status of Project, minimally:
    - a. Approval of minutes of last meeting.
    - b. Review of Work progress.
    - c. Field observations, problems and decisions.
    - d. Identifications of problems which impede planned progress.
    - e. Review of submittal schedule and status of submittals.
    - f. Review of off-site fabrication and delivery schedules.
    - g. Maintenance of progress schedule.
    - h. Corrective measures to regain projected schedules.
    - i. Planned progress during succeeding Work period.
    - j. Coordination of projected progress.
    - k. Maintenance of quality and work standards.
    - l. Effect of proposed changes on progress schedule and coordination.
    - m. Other business relating to Work.

### 1.04 PREINSTALLATION CONFERENCES

- A. When required in individual specification sections, or as requested by Contractor, convene a preinstallation conference at Site prior to commencing Work of the Section.
- B. Attendees: Require attendance of entities directly affecting, or affected by, Work of the Section, including manufacturer's representative.
- C. Notification: Notify Engineer 5 days in advance of meeting date.

D. Contractor Duties:

1. Prepare agenda, preside at conference, record minutes, and distribute copies (2 to Engineer) within 2 days.
2. If Contractor does not preside, record, and distribute meeting notes, Engineer will do so at Engineer's standard hourly rate submitted to Owner. An equivalent amount will be deleted from Contract by Construction Change Directive.

E. Agenda:

1. Review conditions of installation.
2. Review preparation and installation procedures.
3. Coordinate with related Work.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

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**SECTION 01 32 16**  
**PROGRESS SCHEDULES**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Format
  - 2. Content
  - 3. Revisions to Schedules
  - 4. Submittals
  
- B. Related Sections:
  - 1. Section 01 11 00 - Summary of Work
  - 2. Section 01 33 00 - Submittal Procedures

**1.02 FORMAT**

- A. Prepare schedules as a horizontal bar chart (Gantt chart) with separate bar for each major portion of Work or Operation, identifying first workday of each week.
  
- B. Sequence of Listings: The Table of Contents of this Project Manual. The chronological order of the start of each item of work.
  
- C. Scale and Spacing: To provide space for notations and revisions.
  
- D. Sheet Size: Minimum 11 by 17 inches. Provide digital file (.pdf file format). Provide digital working file at the request of Owner/Engineer

**1.03 CONTENT**

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
  
- B. Identify each item by specification section number.
  
- C. Identify Work of separate stages, separate floors, and other logically grouped activities.
  
- D. Provide sub-schedules to define critical portions of the entire schedule as necessitated by the work or as requested by the Owner or Engineer.
  
- E. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
  
- F. Provide separate schedule of submittal dates for Shop Drawings, Product Data, and Samples, including Owner furnished products and products identified under Allowances, and dates reviewed. Submittals will be required from Engineer. Indicate decision date for selection of finishes.
  
- G. Indicate delivery dates for Owner furnished products and products identified under Allowances.
  
- H. Coordinate content with Schedule of Values. Refer to Section 01 29 10.

#### **1.04 REVISIONS TO SCHEDULES**

- A. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
- B. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
- C. Provide narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken, or proposed, and its effect including the effect of changes on schedules of separate contractors.

#### **1.05 SUBMITTALS**

- A. Submit initial schedules within 10 days after date of Owner-Contractor Agreement. After review, resubmit required revised data within 10 days.
- B. Submit revised Progress Schedule with each Application for Payment.
- C. Submit digital file (.pdf file format). Provide digital working file at the request of Owner/Engineer.
- D. Distribute copies of reviewed schedules to Site file, subcontractors, suppliers, and other concerned parties.
- E. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

Not Used

**END OF SECTION**

## SECTION 01 33 00

### SUBMITTAL PROCEDURES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Requirements Included:
  - 1. Electronic Submittal Procedures
  - 2. Procedures
  - 3. Schedule of Values
  - 4. Shop Drawings
  - 5. Product Data
  - 6. Samples
  - 7. List of Proposed Subcontractors
  - 8. List of Proposed Suppliers
  - 9. Material Safety Data Sheets
  - 10. Payment Schedule

##### 1.02 ELECTRONIC SUBMITTAL PROCEDURES

- A. Summary:
  - 1. Shop Drawing and product data submittals shall be transmitted to Engineer in electronic (PDF) format using a submittal exchange/transfer service, a website service designed specifically for transmitting submittals between construction team members.
  - 2. The intent of electronic submittals is to expedite the construction process by reducing paperwork, improving information flow, and decreasing turnaround time.
  - 3. The electronic submittal process is not intended for color samples, color charts or physical material samples.
- B. Procedures:
  - 1. Contractor shall use Newforma submittal exchange platform used by the Engineer for all submittals.
    - a. Owner, Engineer and Contractor will all have access to this platform.
    - b. Engineer will provide a web browser access point for the Contractor and Owner to interface with the Newforma program.
    - c. Subcontractors and Suppliers provide electronic (PDF) submittals to Contractor via the Contractor's preferred submittal platform. Contractor is responsible for getting submittals into Newforma.
  - 2. Contractor shall review and apply electronic stamp certifying that the submittal complies with the requirements of the Contract Documents including verification of manufacturer / product, dimensions and coordination of information with other parts of the work.
  - 3. Contractor shall transmit each submittal to the Engineer using the Newforma submittal exchange service.
  - 4. Engineer review comments will be made available on the Newforma website for downloading. Contractor will receive email notice of completed reviews and other notifications.
  - 5. Distribution of reviewed submittals to subcontractors and suppliers is the responsibility of the Contractor once they are received by the Contractor on Newforma.

##### 1.03 PROCEDURES

- A. Deliver submittals to Engineer via transfer exchange website listed in 1.02 with a Transmittal.
- B. Transmit each item under Engineer-accepted form.
  - 1. Identify Project, Contractor, subcontractor, major supplier.
  - 2. Identify pertinent Drawing sheet and detail number, and specification Section number.

3. Identify deviations from Contract Documents.
  4. Provide space for Engineer and consultant review stamps.
- C. Submit initial progress schedules and schedule of values in duplicate within 10 days after date of Owner-Contractor Agreement. After review by Engineer, revise and resubmit as required.
  - D. Submit revised schedules with each Application for Payment, reflecting changes since previous submittal.
  - E. Comply with progress schedule for submittals related to Work progress. Coordinate submittal of related items.
  - F. After Engineer review of submittal, revise and resubmit as required, identifying changes made since previous submittal.
  - G. Distribute copies of reviewed submittals to concerned persons. Instruct recipients to promptly report any inability to comply with provisions.

#### **1.04 SCHEDULE OF VALUES**

- A. Submit typed schedule on AIA Form G703 or Contractor's standard form.
- B. Format:
  1. Table of Contents of this Project Manual.
  2. Identify each line item with number and title of the major technical sections.
- C. Include in each line a directly proportional amount of Contractor's overhead and profit.
- D. Provide a sub-schedule for each separate stage of Work specified in Section 01 11 00.
- E. Revise schedule to list Change Orders for each application for payment submittal.

#### **1.05 SHOP DRAWINGS**

- A. Shop Drawings will not be accepted for review by Engineer until after they have been checked and approved by the Contractor as evidenced by his approval stamp and signature.
- B. Submit all Shop Drawings electronically in pdf format via the Newforma website.
- C. Submit showing system fabrication, installation drawings including plans, elevations, section details of components, and configuration between system and adjoining systems.

#### **1.06 PRODUCT DATA**

- A. Mark each copy to identify applicable products, models, options, testing compliance, warranty, and other data; supplement manufacturers' standard data to provide information unique to the Work.
- B. Submit all Product Data electronically in pdf format via the Newforma website.
- C. Submit manufacturer's printed instructions for delivery, storage, assembly, installation start-up, adjusting, finishing, and maintenance.

#### **1.07 SAMPLES**

- A. Submit full range of manufacturer's standard colors, textures, and patterns for Engineer's selection. Submit samples for selection of finishes within 30 days after date of Contract.
- B. Submit samples to illustrate functional characteristics of the product, with integral parts and attachment devices. Coordinate submittal of different categories for interfacing Work.



- C. Include identification on each sample, giving full information.
- D. Submit the number specified in respective specification section; 1 will be retained by Engineer. Reviewed samples that may be used in the Work are indicated in the technical sections.
- E. Field Samples:
  - 1. Provide field samples of finishes as required by individual technical section.
  - 2. Install sample complete and finished.
  - 3. Acceptable samples in place may be retained in completed Work.

#### **1.08 LIST OF PROPOSED SUBCONTRACTORS**

- A. Submit a list of subcontractors who will provide Work on the Project.
- B. The submitted list shall include:
  - 1. Name of Subcontractor
  - 2. Address
  - 3. Type of work to be provided
  - 4. Contact list for administrative and supervisory personnel.

#### **1.09 LIST OF PROPOSED SUPPLIERS**

- A. Submit a list of suppliers who will provide materials, equipment or components principle to the Work.
- B. The submitted list should include:
  - 1. Name of supplier.
  - 2. Address.
  - 3. Equipment, material or component to be provided.
  - 4. Contact list for administrative and supervisory personnel.

#### **1.10 MATERIAL SAFETY DATA SHEETS**

- A. Submit MSDS to the Site on all products with chemical emissions and as called for in individual technical sections.

#### **1.11 PAYMENT SCHEDULE**

- A. Submit anticipated monthly payment schedule within 30 days after award of Contract, when requested by Engineer.
- B. Update whenever payment requests vary from the schedule by more than 10 percent.

### **PART 2 PRODUCTS**

Not Used

### **PART 3 EXECUTION**

Not Used

**END OF SECTION**

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## SECTION 01 42 00

### WATERTIGHTNESS TESTING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Criteria for determining watertightness of liquid-retaining tanks and procedures for performing and documenting testing to assure watertightness criteria are met.
- B. The following structures shall be tested and verified to conform to, and achieve the HST-100 and HST-VIO leakage rate requirements:
  - 1. Backwash Tank
  - 2. In general, any liquid-retaining structure or portion of structure. For purposes of this section, this includes structures which may be called upon to keep groundwater out of interior spaces. Groundwater shall be considered to potentially exist up to 8 inches below ground elevation.
  - 3. Interior dividing walls between chambers of the following structures are not required to be watertight. Structures to which this applies are splitter boxes, and all but the center walls of the Aeration Basin (as noted above).

##### 1.02 REFERENCES

- A. American Concrete Institute (ACI):
  - 1. ACI 318 - Building Code Requirements for Structural Concrete.
  - 2. ACI 350 - Environmental Engineering Concrete Structures
  - 3. ACI 350.1 - Tightness Testing of Environmental Engineering Concrete Structures.

##### 1.03 SUBMITTALS

- A. Submittals shall conform to Section 01 33 00.
- B. Submit written procedures, sequencing and schedule for watertightness testing of each liquid-retaining tank to be tested. Indicate level of watertightness to be achieved and source of water to be used for testing.

##### 1.04 QUALITY ASSURANCE

- A. Testing shall comply with ACI 350, except as modified in this Section.

##### 1.05 MEASUREMENT AND PAYMENT

- A. The Work of this Section will not be measured for separate payment. All Work described, including remedial measures required to meet tank watertightness criteria shall be included in the Lump Sum Base Bid.

#### PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.01 WATERTIGHTNESS TESTING PROCEDURE

- A. All concrete structures that are to contain, retain, exclude, or convey liquid shall be liquid tight, such that the specified leakage rate is not exceeded. All tanks shall be leak tested as specified below. The Contractor shall be responsible for all costs of coordinating and conducting the leakage testing, as well as all repairs and remedial measures necessary to meet specified leakage rate.
- B. Each cell of multi-cell tanks shall be considered a single tank and tested individually, unless otherwise directed by the Engineer. See paragraph 1.01.
- C. Unless specifically allowed by the Engineer, the tank shall not be tested before all of the structure is complete and the tank's concrete has attained its specified compressive strength. A "complete" structure includes connected walkways, exterior stairways, wall or roof beams, or other structural elements above or outside of the tank's liquid containment shell.
- D. No soil backfill, coatings, or other obstructive materials shall be placed against the inside or outside of the tanks requiring testing until they have been tested and shown to meet the specified leakage criterion. In the case of structures over 20 feet deep, leakage test may be run in phases. Backfill may then be placed up to an elevation 4 feet below water level maintained during that phase of the successful leak test.
- E. Note that crystalline waterproofing admixtures are temperature-dependent and may not function at all below temperatures of approximately 40 degrees F. Further note that these materials may require outside water sources to fully seal cracks. Contractor shall take this into consideration when scheduling leak testing and backfilling.
- F. Perform Watertightness Testing as Follows:
  - 1. Clean the exposed concrete surfaces of the tank, including the floor, of all foreign material and debris. Standing water in or outside of the tank that would interfere with the observation of the exposed concrete surfaces of the tank shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Repair areas of potential leakage prior to filling the tank with water.
  - 2. All openings, fittings, and pipe penetrations in the tank shell shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired. No surface coatings shall be applied prior to tank testing and approval by the Engineer.
  - 3. All tank penetrations and outlets shall be securely sealed to prevent the loss of water from the tank during the test. If the tank is to be filled using the tank inlet pipe, positive means shall be provided to verify that water is not entering or leaving the tank through this pipe once the tank is filled to test level.
  - 4. Tank penetration and pipe, channel, and conduit outlets shall be monitored before and during the test to determine the watertightness of these appurtenances. Leakage at these outlets shall be repaired prior to test measurements. No allowance shall be made in test measurements for uncorrected known points of leakage. The flow from any underdrain system shall be monitored during this same period and any increase in flow shall be recorded.
  - 5. The ground water level shall be brought to a level below the top of the base slab and kept below the top of the base slab during the test.
  - 6. The initial filling of a new tank shall not exceed a rate of 4 feet/hour. Filling shall be continued until the water surface is at the design maximum liquid level or 4 inches below any fixed overflow level, whichever is lower.
  - 7. Maintain water at the test level of unlined concrete tanks for at least 2 days prior to the actual test.
  - 8. Inspect the exterior surfaces of the tank during the tank filling period. If any flow of water is observed from the tank exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired per Paragraph 3.03 of this Specification.

G. Watertightness Test Measurements Shall be Conducted as Follows:

1. Test measurements shall not be scheduled for a period when the forecast is for a substantial change in the weather pattern.
2. The test shall also not be scheduled when the weather forecast indicates the water surface would be frozen before the test is completed.
  - a. It is the option of the owner to allow for leak testing in temperatures below freezing if proper heating is in place to maintain concrete and water above 45 degrees and with an approved cold-weather watertightness testing plan, submitted and agreed upon by all parties. Any ice formation (or temperature readings of less than 45 degrees) on the outside face of the tank or at the top of the water constitute a failing leak test result.
3. Measure the vertical distance to the water surface from a fixed point on the tank above the water surface. Take measurements at a minimum of 2 locations, 180 degrees apart, and preferably at 4 locations, 90 degrees apart. Measurements shall be recorded at regular intervals with a minimum of 4 times throughout a 24-hour period.
4. The test period shall be at conducted for a minimum of 24 hours (after the 2-day absorption period) unless the test fails the leakage requirements in a shorter time period.
5. Record the water temperature at a depth of 18 inches below the water surface.
6. Measure evaporation and precipitation in uncovered tanks. For covered tanks, vents, hatches, and other openings shall be closed, sealed, plugged, or otherwise made vapor-tight; after the absorption period, evaporation will be assumed to be negligible.
  - a. Evaporation loss can be measured by comparing evaporation loss in an uncovered, 55-gallon PVC barrel.
7. Inspect the tank regularly for damp spots, seepage, and leakage.
8. Calculate the change in water volume in the tank, including corrections, if necessary, for evaporation, precipitation, and temperature. If the loss exceeds the required criterion, the tank shall be considered to have failed the test. The tank shall also be considered to have failed the test if water is observed flowing or seeping from the tank or if moisture can be transferred from the non-water-side surface to a dry hand. Dampness or wetness on top of a footing in the absence of flowing water shall not be considered as a failure to meet the acceptance criterion.

H. Determine HST Leakage Rate:

1. Standard hydrostatic tests shall have the prefix HST, followed by the test criterion expressed as the maximum allowable percent loss per day of the test water volume. Unless noted, all tanks shall meet the leakage criterion for HST-100 and HST-VIO.
2. The allowable loss of water for HST-025, HST-050, HST-075, and HST-100 tightness tests shall not exceed the values in the following table:

<b>Designation</b>	<b>Tightness Criterion</b>
HST-NML	No measurable loss
HST-025	0.025 percent per day
HST-050	0.050 percent per day
HST-075	0.075 percent per day
HST-100	0.100 percent per day
HST-VIO	Visual inspection only

3. There is no numerical value for the allowable loss of water during the HST-VIO tightness test. However, no flow or seepage of water from the tank shall be present on the non-water-side surfaces for 24 hours after the tank is filled to test level. Moisture-darkened areas on wall external surfaces with flow insufficient to cause moisture to be able to be picked up on a dry hand are considered acceptable.
4. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.

### **3.02 REMEDIAL AND CORRECTIVE MEASURES**

- A. Remedial measures shall be taken to ensure that all tanks meet the specified leakage test criterion, and that no visible leakage is observed through concrete joints or surfaces exposed to view. Remedial actions may include drilling and injecting epoxy or chemical grout as specified in Section 03 30 00.
- B. Repeat testing until specified leakage rate is achieved or leakage is no longer observed.
- C. Contractor shall be responsible for the cost of water used in any retests. No extension of contract times or approval of additional costs will be granted due to failure to pass watertightness tests.

### **3.03 DOCUMENTATION OF TESTING AND RESULTS**

- A. Keep written records for all watertightness testing performed and the results of the testing. Indicate the actual leakage rate measured versus the leakage criteria specified.
- B. Document specific locations where leakage is detected, and remedial measures taken to stop leakage.

**END OF SECTION**

## SECTION 01 42 18

### REFERENCE STANDARDS FOR INFRASTRUCTURE IMPROVEMENTS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Quality Assurance.
- B. List of References.

##### 1.02 QUALITY ASSURANCE

- A. For products or workmanship specified by Association, trade, or federal and state standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents.
- C. Obtain copies of standards when required by Contract Documents.
- D. Maintain copy at jobsite during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- F. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

##### 1.03 LIST OF NATIONAL REFERENCES

AABC	Associated Air Balance Council 1518 K Street NW Washington, DC 20005 202.737.0202 <a href="http://www.aabc.com">www.aabc.com</a>	ADA	Americans with Disabilities Act US Dept. of Justice 950 Pennsylvania Avenue NW Civil Rights Division/Disability Rights Section - NYA Washington, DC 20530 800.514.0301 <a href="http://www.ada.gov">www.ada.gov</a>
AASHTO	Am. Assoc. of State Hwy. & Transportation Officials 444 N. Capital Street NW, Ste. 249 Washington, DC 20001 202.624.5800 <a href="http://www.transportation.org">www.transportation.org</a>	AGA	American Gas Assoc. 400 N. Capitol Street NW Washington, DC 20001 202.824.7000 <a href="http://www.aga.org">www.aga.org</a>
ABMA	American Bearing Manufacturers Association 2025 M Street, NW, Suite 800 Washington, DC 20036 202.367.1155	AGC	Associated General Contractors of America 2300 Wilson Boulevard., Ste. 400 Arlington, VA 22201 703.548.3118 <a href="http://www.agc.org">www.agc.org</a>
ACC	American Chemistry Council 700 Second Street NE Washington, DC 20002 202.249.7000 <a href="http://www.plastics.americanchemistry.com">www.plastics.americanchemistry.com</a>	AI	Asphalt Institute 2696 Research Park Drive Lexington, KY 40511-8480 859.288.4960 <a href="http://www.asphaltinstitute.org">www.asphaltinstitute.org</a>
ACEC	American Council of Engineering Companies 1015 15th Street, 8th Floor, NW Washington DC 20005-2605 202.347.7474 <a href="http://www.acec.org">www.acec.org</a>	AISI	American Iron & Steel Institute 1140 Connecticut Avenue NW, Ste. 705 Washington, DC 20036 202.452.7100 <a href="http://www.steel.org">www.steel.org</a>

ANSI	American National Standards Institute 1819 L Street NW, 6th Floor Washington, DC 20036 202.293.8020 <a href="http://www.ansi.org">www.ansi.org</a>	EIMA	EIFS Industry Members Assoc. 513 West Broad Street, Ste. 210 Falls Church, VA 22046-3257 800.294.3462 <a href="http://www.eima.com">www.eima.com</a>
ARRA	Asphalt Recycling & Reclaiming Assoc. #3 Church Circle – PMB 250 Annapolis, MD 21401 410.267.0023 <a href="http://www.arra.org">www.arra.org</a>	EJCDC®	Engineers' Joint Contract Documents Committee® See ACEC, AGC, ASCE, and NSPE <a href="http://www.ejcdc.org">www.ejcdc.org</a>
ASCE	American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191-4400 800.548.2723 <a href="http://www.asce.org">www.asce.org</a>	EPA	U.S. Environmental Protection Agency Ariel Rios Building 1200 Pennsylvania Ave. NW Washington, DC 20004 202.272.0167 <a href="http://www.epa.gov">www.epa.gov</a>
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428-2959 610.832.9500 <a href="http://www.astm.org">www.astm.org</a>	FEMA	Federal Emergency Management Assoc. 500 C Street SW Washington, DC 20472 800.621.3362 <a href="http://www.fema.gov">www.fema.gov</a>
AWMA	Air & Waste Management Assoc. One Gateway Center, 3rd Floor 420 Fort Duquesne Blvd. Pittsburgh, PA 15222-1435 412.232.3444 <a href="http://www.awma.org">www.awma.org</a>	FMG	FM Global (Factory Mutual System) 270 Central Avenue, PO Box 7500 Johnston, RI 02919 401.275.3000 <a href="http://www.fmglobal.com">www.fmglobal.com</a>
AWWA	American Water Works Assoc. 6666 W. Quincy Avenue Denver, CO 80235 800.926.7337 <a href="http://www.awwa.org">www.awwa.org</a>	Green Seal	Green Seal 1001 Connecticut Avenue NW, Ste. 827 Washington, DC 20036-5525 202.872.6400 <a href="http://www.greenseal.org">www.greenseal.org</a>
CDA	Copper Development Assoc. 260 Madison Avenue New York, NY 10016 212.251.7200 <a href="http://www.copper.org">www.copper.org</a>	Green-e	Green-e Program Center for Resource Solutions 1012 Torney Avenue, Second Floor PO Box 29512 San Francisco, CA 94129 415.561.2100 <a href="http://www.green-e.org">www.green-e.org</a>
CPI	Concrete Paver Institute, a division of NCMA See ICPI	Green Guard	Greenguard Environmental Institute 2211 Newmarket Parkway, Ste. 110 Marietta, GA 30067 800.427.9681 <a href="http://www.greenguard.org">www.greenguard.org</a>
CLFMI	Chain Link Fence Manufacturers Institute 10015 Old Columbia Rd, Ste. B-215 Columbia, MD 21046 410.290.6267 <a href="http://www.chainlinkinfo.org">www.chainlinkinfo.org</a>	GRI	Geosynthetic Research Institute See GSI
CMRA	Construction Materials Recycling Assoc. 1001 I Street, PO Box 40125 Sacramento, CA 95812-4025 916.341.4027 <a href="http://www.calrecycle.ca.gov/RCP">www.calrecycle.ca.gov/RCP</a>	GSI	Geosynthetic Institute 475 Kedron Avenue Folsom, PA 19033-1208 610.522.8440 <a href="http://www.geosynthetic-institute.org">www.geosynthetic-institute.org</a>
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Road Schaumburg, IL 60173-4758 847.517.1200 <a href="http://www.crsi.org">www.crsi.org</a>	ICEA	Insulated Cable Engineers Association, Inc. P.O. Box 1568 Carrollton, GA 30112 <a href="http://www.icea.net">www.icea.net</a>
CSI	Construction Specifications Institute 110 South Union Street, Ste. 100 Alexandria VA 22314 800.689.2900 <a href="http://www.csinet.org">www.csinet.org</a>	ICPI	Interlocking Concrete Pavement Institute 13921 Park Center Road, Ste. 270 Herndon VA 20171 703.657.6900 <a href="http://www.icpi.org">www.icpi.org</a>
DOE	U.S. Department of Energy 1000 Independence Ave. SW Washington DC 20585 202.586.5000 <a href="http://www.energy.gov">www.energy.gov</a>	IMI	International Masonry Institute 42 East Street Annapolis, MD 21401 410.280.1305 <a href="http://www.imiweb.org">www.imiweb.org</a>
DOT	U.S. Department of Transportation 1200 New Jersey Ave, SE Washington, DC 20590 202.366.4000 <a href="http://www.dot.gov">www.dot.gov</a>	IPBA	International Pipe Bursting Assoc. Division of NASSCO 410.486.3500 <a href="http://www.nassco.org/about_nassco/an_div_ipba.html">www.nassco.org/about_nassco/an_div_ipba.html</a>
EEOC	Equal Employment Opportunity Commission 131 M Street NE Washington, DC 20507 800.669.4000 <a href="http://www.eeoc.gov">www.eeoc.gov</a>	LEED	Leadership in Energy and Environmental Design See USGBC



MIA	Masonry Institute of America 22815 Frampton Avenue Torrance, CA 90501-5034 800.221.4000 <a href="http://www.masonryinstitute.org">www.masonryinstitute.org</a>	NSSGA	National Stone, Sand & Gravel Assoc. 1605 King Street Alexandria, VA 22314 703.525.8788 <a href="http://www.nssga.org">www.nssga.org</a>
MSS	Manufacturers Standardization Society of the Valve and Fitting Industry 127 Park St NE Vienna, VA 22180-4602 703.281.6613 <a href="http://www.mss-hq.com">www.mss-hq.com</a>	OSHA	U. S. Occupational Safety and Health Administration 200 Constitution Avenue NW Washington, DC 20210 800.321.6742 <a href="http://www.osha.gov">www.osha.gov</a>
MUTCD	Manual on Uniform Traffic Control Devices <a href="http://www.mutcd.fhwa.dot.gov">www.mutcd.fhwa.dot.gov</a>	PCA	Portland Cement Assoc. 5420 Old Orchard Road Skokie, IL 60077 847.966.6200 <a href="http://www.cement.org">www.cement.org</a>
NACE	National Assoc. of Corrosion Engineers 1440 S. Creek Drive Houston, TX 77084-4906 281.228.6200 <a href="http://www.nace.org">www.nace.org</a>	PCI	Precast/Prestressed Concrete Institute 200 W. Adams Street, #2100 Chicago, IL 60606 312.786.0300 <a href="http://www.pci.org">www.pci.org</a>
NCMA	National Concrete Masonry Assoc. 13750 Sunrise Valley Drive Herndon, VA 20171-4662 703.713.1900 <a href="http://www.ncma.org">www.ncma.org</a>	PCI Midwest	952.806.9997 <a href="http://www.midwestprecast.com">www.midwestprecast.com</a>
NEC	National Electric Code See NFPA	PPI	Plastics Pipe Institute 105 Decker Court, Ste. 825 Irving TX, 75062 469.499.1044 <a href="http://www.plasticpipe.org">www.plasticpipe.org</a>
NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877 301.977.3698 <a href="http://www.nebb.org">www.nebb.org</a>	SSPC	Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222-4656 877.281.7772 <a href="http://www.sspc.org">www.sspc.org</a>
NEMA	National Electrical Manufacturers Assoc. 1300 N. 17th Street., Ste. 1752 Rosslyn, VA 22209 703.841.3200 <a href="http://www.nema.org">www.nema.org</a>	TMS	The Masonry Society 105 South Sunset Street, Ste. Q Longmont, Colorado, 80501-6172 303.939.9700 <a href="http://www.masonrysociety.org">www.masonrysociety.org</a>
NFPA	National Fire Protection Assoc. 1 Batterymarch Park Quincy, MA 02169-7471 617.770.3000 <a href="http://www.nfpa.org">www.nfpa.org</a>	TPI	Turfgrass Producers International 2 East Main Street East Dundee, IL 60118 800.405.8873 <a href="http://www.turfgrasssod.org">www.turfgrasssod.org</a>
NIOSH	National Institute for Occupational Safety and Health Centers for Disease Control and Prevention 1600 Clifton Road Atlanta, GA 30333 800.232.4636 <a href="http://www.cdc.gov/niosh">www.cdc.gov/niosh</a>	UL	Underwriters' Laboratories, Inc. 2600 N.W. Lake Rd. Camas, WA 98607-8542 877.854.3577 <a href="http://www.ul.com">www.ul.com</a>
NPCA	National Precast Concrete Assoc. 1320 City Center Drive, Suite 200 Carmel, IN 46032 800.366.7731 <a href="http://www.precast.org">www.precast.org</a>	USACE	U.S. Army Corps of Engineers Publication Department 2803 52nd Avenue Hyattsville, MD 20781-1102 301.394.0081 <a href="http://www.usace.army.mil">www.usace.army.mil</a>
NPDES	National Pollutant Discharge Elimination System <a href="http://www.epa.gov">www.epa.gov</a>	USGBC	U.S. Green Building Council 2101 L Street, Ste. 500 Washington DC 20037 800.795.1747 <a href="http://www.usgbc.org">www.usgbc.org</a>
NSF	NSF International 789 N. Dixboro Road, PO Box 130140 Ann Arbor, MI 48113-0140 800.673.6275 <a href="http://www.nsf.org">www.nsf.org</a>	WQA	Water Quality Assoc. 4151 Naperville Road Lisle, IL 60532-3696 630.505.0160 <a href="http://www.wqa.org">www.wqa.org</a>
NSPE	National Society of Professional Engineers 1420 King Street Alexandria, VA 22314-2794 703.684.2800 <a href="http://www.nspe.org">www.nspe.org</a>		
NSWMA	National Solid Wastes Management Assoc. 4301 Connecticut Avenue NW, Ste. 300 Washington, DC 20008 800.424.2869 <a href="http://www.environmentalistseveryday.org/about-nswma-solid-waste-management">www.environmentalistseveryday.org/about-nswma-solid-waste-management</a>		

#### 1.04 LIST OF STATE REFERENCES

WDNR Wisconsin Department of Natural Resources  
101 S. Webster, PO Box 7921  
Madison, WI 53707  
608.266.2621 [www.dnr.wi.gov](http://www.dnr.wi.gov)

WMUTCD WI Manual on Uniform Traffic Control Devices  
Division of Transportation  
4802 Sheboygan Avenue  
Madison, WI 53707  
608.266.0150 [www.dot.Wisconsin.gov](http://www.dot.Wisconsin.gov)

WisDOT Wisconsin Department of Transportation  
4802 Sheboygan Avenue, PO Box 7916  
Madison, WI 53707  
[www.dot.state.wi.us](http://www.dot.state.wi.us)

WEDC Wisconsin Economic Development Corporation  
PO Box 7962  
Madison, WI 53707  
[www.wedc.org](http://www.wedc.org)

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

## SECTION 01 42 19

### REFERENCE STANDARDS FOR BUILDING CONSTRUCTION

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Quality Assurance.
- B. List of References.

##### 1.02 QUALITY ASSURANCE

- A. For products or workmanship specified by Association, trade, or federal and state standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents.
- C. Obtain copies of standards when required by Contract Documents.
- D. Maintain copy at jobsite during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- F. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

##### 1.03 LIST OF NATIONAL REFERENCES

AA	Aluminum Assoc. 1525 Wilson Boulevard, Ste. 600 Arlington, VA 22209 703.358.2960 <a href="http://www.aluminum.org">www.aluminum.org</a>	ACC	American Chemistry Council 700 Second Street NE Washington, DC 20002 202.249.7000 <a href="http://www.plastics.americanchemistry.com">www.plastics.americanchemistry.com</a>
AABC	Associated Air Balance Council 1518 K Street NW Washington, DC 20005 202.737.0202 <a href="http://www.aabc.com">www.aabc.com</a>	ACEC	American Council of Engineering Companies 1015 15th Street, 8th Floor, NW Washington DC 20005-2605 202.347.7474 <a href="http://www.acec.org">www.acec.org</a>
AAMA	American Architectural Manufacturer's Assoc. 1827 Walden Office Square, Ste. 550 Schaumburg, IL 60173-4268 847.303.5664 <a href="http://www.aamanet.org">www.aamanet.org</a>	ACIL	American Council of Independent Laboratories 1875 I Street, NW, Ste. 500 Washington, DC 20006 202.887.5872 <a href="http://www.acil.org">www.acil.org</a>
AASHTO	Am. Assoc. of State Hwy. & Transportation Officials 444 N. Capital Street NW, Ste. 249 Washington, DC 20001 202.624.5800 <a href="http://www.transportation.org">www.transportation.org</a>	ACS	American Ceramic Society 600 N. Cleveland Avenue, Ste. 210 Westerville, OH 43082 866.721.3322 <a href="http://www.acers.org">www.acers.org</a>
AATCC	American Assoc. of Textile Chemists and Colorists 1 Davis Drive, PO Box 12215 Research Triangle Park, NC 27709-2215 919.549.8141 <a href="http://www.aatcc.org">www.aatcc.org</a>	ADA	Americans with Disabilities Act US Dept. of Justice 950 Pennsylvania Avenue NW Civil Rights Division/Disability Rights Section - NYA Washington, DC 20530 800.514.0301 <a href="http://www.ada.gov">www.ada.gov</a>
ACAC	American Council for Accredited Certification PO Box 1000 Yarnell, AZ 85362 888.808.8381 <a href="http://www.acac.org">www.acac.org</a>		

AGA	American Gas Assoc. 400 N. Capitol Street NW Washington, DC 20001 202.824.7000 <a href="http://www.aga.org">www.aga.org</a>	ARMA	Asphalt Roofing Manufacturers Assoc. Public Information Department 750 National Press Building 529 14th Street NW Washington, DC 20045 202.207.0917 <a href="http://www.asphaltroofing.org">www.asphaltroofing.org</a>
AGC	Associated General Contractors of America 2300 Wilson Boulevard., Ste. 400 Arlington, VA 22201 703.548.3118 <a href="http://www.agc.org">www.agc.org</a>	ARRA	Asphalt Recycling & Reclaiming Assoc. #3 Church Circle – PMB 250 Annapolis, MD 21401 410.267.0023 <a href="http://www.arra.org">www.arra.org</a>
AGMA	American Gear Manufacturers Assoc. 1001 N. Fairfax Street, Ste. 500 Alexandria, VA 22314-1587 703.684.0211 <a href="http://www.agma.org">www.agma.org</a>	ASA	Acoustical Society of America Suite 1NO1 2 Huntington Quadrangle 516.576.2360 <a href="http://www.acousticalsociety.org">www.acousticalsociety.org</a>
AHMA	American Hardware Manufacturers 801 N. Plaza Drive Schaumburg, IL 60173-4977 847.605.1025 <a href="http://www.ahma.org">www.ahma.org</a>	ASC	Adhesive and Sealant Council 7101 Wisconsin Avenue, Ste. 990 Bethesda, Maryland 20814 301.986.9700 <a href="http://www.ascouncil.org">www.ascouncil.org</a>
AHRI	Air-Conditioning, Heating, and Refrigeration Institute 2111 Wilson Boulevard, Ste. 500 Arlington, VA 22201 703.524.8800 <a href="http://www.ahrinet.org">www.ahrinet.org</a>	ASCE	American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191-4400 800.548.2723 <a href="http://www.asce.org">www.asce.org</a>
AI	Asphalt Institute 2696 Research Park Drive Lexington, KY 40511-8480 859.288.4960 <a href="http://www.asphaltinstitute.org">www.asphaltinstitute.org</a>	ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineering 1791 Tullie Circle NE Atlanta, GA 30329-2305 800.527.4723 <a href="http://www.ashrae.org">www.ashrae.org</a>
AIA	American Institute of Architects 1735 New York Avenue NW Washington, DC 20006-5292 800.242.3837 <a href="http://www.aia.org">www.aia.org</a>	ASI	Australian Steel Institute Level 13, 99 Mount Street North Sidney NSW 2060 <a href="http://www.steel.org.au">www.steel.org.au</a>
AISI	American Iron & Steel Institute 1140 Connecticut Avenue NW, Ste. 705 Washington, DC 20036 202.452.7100 <a href="http://www.steel.org">www.steel.org</a>	ASID	American Society of Interior Designers 608 Massachusetts Avenue NE Washington DC 20002-6006 202.546.3480 <a href="http://www.asid.org">www.asid.org</a>
AITC	American Institute of Timber Construction 7012 S. Revere Parkway, Ste. 140 Centennial, CO 80112 303.792.9559 <a href="http://www.aitc-glulam.org">www.aitc-glulam.org</a>	ASLA	American Society of Landscape Architects 636 Eye Street NW Washington DC 20001-3736 202.898.2444 <a href="http://www.asla.org">www.asla.org</a>
ALSC	American Lumber Standards Committee PO Box 210 Germantown, MD 20875-0210 301.972.1700 <a href="http://www.alsc.org">www.alsc.org</a>	ASME	American Society of Mechanical Engineers 22 Law Drive, PO Box 2300 Fairfield, NJ 07007-2300 800.843.2763 <a href="http://www.asme.org">www.asme.org</a>
AMCA	Air Movement & Control Assoc. 30 W. University Drive Arlington Heights, IL 60004 847.394.0150 <a href="http://www.amca.org">www.amca.org</a>	ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428-2959 610.832.9500 <a href="http://www.astm.org">www.astm.org</a>
ANSI	American National Standards Institute 1819 L Street NW, 6th Floor Washington, DC 20036 202.293.8020 <a href="http://www.ansi.org">www.ansi.org</a>	ATHENA	Athena Sustainable Materials Institute 119 Ross Avenue, Ste. 100 Ottawa, Ontario, Canada K1Y 0N6 613.729.9996 <a href="http://www.athenasmi.org">www.athenasmi.org</a>
APA	APA - The Engineered Wood Assoc. 7011 S. 19th Street Tacoma, WA 98466-5333 253.565.6600 <a href="http://www.apawood.org">www.apawood.org</a>	AWI	Architectural Woodwork Institute 46179 Westlake Drive, Ste. 120 Potomac Falls, VA 20165-5874 571.323.3636 <a href="http://www.awinet.org">www.awinet.org</a>
API	American Petroleum Institute 1220 L Street NW Washington, DC 20005-4070 202.682.8000 <a href="http://www.api.org">www.api.org</a>	AWMA	Air & Waste Management Assoc. One Gateway Center, 3rd Floor 420 Fort Duquesne Blvd. Pittsburgh, PA 15222-1435 412.232.3444 <a href="http://www.awma.org">www.awma.org</a>

AWPA	American Wood Protection Assoc. 100 Chase Park South, Ste. 116 Birmingham, AL 35244-1851 205.733.4077 <a href="http://www.awpa.com">www.awpa.com</a>	CPI	Concrete Paver Institute, a division of NCMA See ICPI
AWPC	American Wind Power Center 1701 Canyon Lake Drive Lubbock, TX 79403 806.747.8734 <a href="http://www.windmill.com">www.windmill.com</a>	CISCA	Ceilings & Interiors Systems Construction Assoc. 405 Illinois Avenue, 2B St Charles IL 60174 630.584.1919 <a href="http://www.cisca.org">www.cisca.org</a>
AWS	American Welding Society 550 NW LeJeune Road Miami, FL 33126 800.443.9353 <a href="http://www.aws.org">www.aws.org</a>	CLFMI	Chain Link Fence Manufacturers Institute 10015 Old Columbia Rd, Ste. B-215 Columbia, MD 21046 410.290.6267 <a href="http://www.chainlinkinfo.org">www.chainlinkinfo.org</a>
AWWA	American Water Works Assoc. 6666 W. Quincy Avenue Denver, CO 80235 800.926.7337 <a href="http://www.awwa.org">www.awwa.org</a>	CMRA	Construction Materials Recycling Assoc. 1001 I Street, PO Box 40125 Sacramento, CA 95812-4025 916.341.4027 <a href="http://www.calrecycle.ca.gov/RCP">www.calrecycle.ca.gov/RCP</a>
BFRL	Building and Fire Research Laboratory See NIST	CPSC	Consumer Product Safety Commission 4330 E-W Highway Bethesda, MD 20814-4408 800.638.2772 <a href="http://www.cpsc.gov">www.cpsc.gov</a>
BHMA	Builders Hardware Manufacturers Assoc. 355 Lexington Avenue, 15th Floor New York, NY 10017 212.297.2122 <a href="http://www.buildershardware.com">www.buildershardware.com</a>	CRA	California Redwood Assoc. 818 Grayson Road, Suite 201 Pleasant Hill, CA 94523 888.225.7339 <a href="http://www.calredwood.org">www.calredwood.org</a>
BIA	Brick Industry Assoc. 1850 Centennial Park Drive, Ste. 301 Reston, VA 20191 703.620.0010 <a href="http://www.gobrick.com">www.gobrick.com</a>	CRI	Carpet and Rug Institute 730 College Drive, PO Box 2048 Dalton, GA 30722-2048 706.278.3176 <a href="http://www.carpet-rug.org">www.carpet-rug.org</a>
BIFMA	Business and Institutional Furniture Manufacturer's Assoc. 678 Front Avenue NW, Ste. 150 Grand Rapids, MI 49504-5368 616.285.3963 <a href="http://www.bifma.com">www.bifma.com</a>	CRRA	Cool Roof Rating Council 1610 Harrison Street Oakland, CA 94612 866.465.2523 <a href="http://www.coolroofs.org">www.coolroofs.org</a>
BMRA	Building Material Reuse Association PO Box 47776 Chicago, IL 60647 773.340.2672 <a href="http://www.bmra.org">www.bmra.org</a>	CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Road Schaumburg, IL 60173-4758 847.517.1200 <a href="http://www.crsi.org">www.crsi.org</a>
Building Green	BuildingGreen, LLC 122 Birge Street, Ste. 300 Brattleboro, VT 05301 802.257.7300 <a href="http://www.buildinggreen.com">www.buildinggreen.com</a>	CSBA	California Straw Buildings Assoc. PO B 1293 Angels Camp, CA 95222 209.785.7077 <a href="http://www.strawbuilding.org">www.strawbuilding.org</a>
CDA	Copper Development Assoc. 260 Madison Avenue New York, NY 10016 212.251.7200 <a href="http://www.copper.org">www.copper.org</a>	CSI	Construction Specifications Institute 110 South Union Street, Ste. 100 Alexandria VA 22314 800.689.2900 <a href="http://www.csinet.org">www.csinet.org</a>
CFPA	Chlorine Free Products Assoc. 19 N. Main Street Algonquin, IL 60102 847.658.6104 <a href="http://www.chlorinefreeproducts.org">www.chlorinefreeproducts.org</a>	CSSB	Cedar Shingle and Shake Bureau PO Box 1178 Sumas, WA 98295-1178 604.820.7700 <a href="http://www.cedarbureau.org">www.cedarbureau.org</a>
CGA	Canadian Gas Assoc. 350 Sparks Street, Ste. 809 Ottawa, Ontario K1R 7S8 613.748.0057 <a href="http://www.cga.ca">www.cga.ca</a>	DHI	Door and Hardware Institute 14150 Newbrook Drive, Ste. 200 Chantilly, VA 20151-2232 703.222.2010 <a href="http://www.dhi.org">www.dhi.org</a>
CGA	Compressed Gas Assoc. 14501 George Carter Way, Ste. 103 Chantilly, VA 20151 703.788.2700 <a href="http://www.cganet.com">www.cganet.com</a>	DOE	U.S. Department of Energy 1000 Independence Ave. SW Washington DC 20585 202.586.5000 <a href="http://www.energy.gov">www.energy.gov</a>
CI	Chlorine Institute, Inc. 1300 Wilson Boulevard, Ste. 525 Arlington, VA 22209 703.894.4140 <a href="http://www.chlorineinstitute.org">www.chlorineinstitute.org</a>	DOT	U.S. Department of Transportation 1200 New Jersey Ave, SE Washington, DC 20590 202.366.4000 <a href="http://www.dot.gov">www.dot.gov</a>

EEOC	Equal Employment Opportunity Commission 131 M Street NE Washington, DC 20507 800.669.4000 <a href="http://www.eeoc.gov">www.eeoc.gov</a>	GSA	U.S. GENERAL SERVICES ADMINISTRATION 1800 F Street, NW Washington, DC 20405 Ph: 202.501.0800 Internet: <a href="http://www.GSA.gov">www.GSA.gov</a> Obtain documents from: Acquisition Streamlining and Standardization Information System (ASSIST) Department of Defense Single Stock Point (DODSSP) Document Automation and Production Service (DAPS) Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 Ph: 215.697.6396 - for account/password issues Internet: <a href="http://assist.daps.dla.mil/online/start/">http://assist.daps.dla.mil/online/start/</a> ; account registration required
EIMA	EIFS Industry Members Assoc. 513 West Broad Street, Ste. 210 Falls Church, VA 22046-3257 800.294.3462 <a href="http://www.eima.com">www.eima.com</a>		
EJCDC®	Engineers' Joint Contract Documents Committee® See ACEC, AGC, ASCE, and NSPE <a href="http://www.ejcdc.org">www.ejcdc.org</a>		
EJMA	Expansion Joint Manufacturers Assoc. 25 N. Broadway Tarrytown, NY 10591 914.332.0040 <a href="http://www.ejma.org">www.ejma.org</a>		
EPA	U.S. Environmental Protection Agency Ariel Rios Building 1200 Pennsylvania Ave. NW Washington, DC 20004 202.272.0167 <a href="http://www.epa.gov">www.epa.gov</a>	GSI	Geosynthetic Institute 475 Kedron Avenue Folsom, PA 19033-1208 610.522.8440 <a href="http://www.geosynthetic-institute.org">www.geosynthetic-institute.org</a>
FEMA	Federal Emergency Management Assoc. 500 C Street SW Washington, DC 20472 800.621.3362 <a href="http://www.fema.gov">www.fema.gov</a>	HHS	Department of Health and Human Services 200 Independence Ave. SW Washington DC 20201 877.696.6775 <a href="http://www.hhs.gov">www.hhs.gov</a>
FMG	FM Global (Factory Mutual System) 270 Central Avenue, PO Box 7500 Johnston, RI 02919 401.275.3000 <a href="http://www.fmgglobal.com">www.fmgglobal.com</a>	HI	Hydraulic Institute 6 Campus Drive, First Floor North Parsippany NJ, 07054-4406 973.267.9700 <a href="http://www.pumps.org">www.pumps.org</a>
FSCUS	Forest Stewardship Council-US 212 Third Avenue North, Ste. 504 Minneapolis, MN 55401 612.353.4511 <a href="http://www.fscus.org">www.fscus.org</a>	HPVA	Hardwood Plywood & Veneer Assoc. 1825 Michael Faraday Drive Reston, Virginia 20190 703.435.2900 <a href="http://www.hpva.org">www.hpva.org</a>
GA	Gypsum Assoc. 6525 Belcrest Road, Ste. 480 Hyattsville, MD 20782 301.277.8686 <a href="http://www.gypsum.org">www.gypsum.org</a>	HUD	U.S. Dept. of Housing & Urban Development 451 7th Street SW Washington, DC 20410 202.708.1112 <a href="http://www.hud.gov">www.hud.gov</a>
GANA	Glass Assoc. of North America 800 SW Jackson Street, Ste. 1500 Topeka, KS 66612-1200 785.271.0208 <a href="http://www.glasswebsite.com">www.glasswebsite.com</a>	IBC	International Building Code See ICC
Green Seal	Green Seal 1001 Connecticut Avenue NW, Ste. 827 Washington, DC 20036-5525 202.872.6400 <a href="http://www.greenseal.org">www.greenseal.org</a>	ICBO	International Conference of Building Officials See ICC
Green-e	Green-e Program Center for Resource Solutions 1012 Torney Avenue, Second Floor PO Box 29512 San Francisco, CA 94129 415.561.2100 <a href="http://www.green-e.org">www.green-e.org</a>	ICC	International Code Council 500 New Jersey Avenue NW, 6th Floor Washington, DC 20001 888.422.7233 <a href="http://www.iccsafe.org">www.iccsafe.org</a>
Green Guard	Greenguard Environmental Institute 2211 Newmarket Parkway, Ste. 110 Marietta, GA 30067 800.427.9681 <a href="http://www.greenguard.org">www.greenguard.org</a>	ICPI	Interlocking Concrete Pavement Institute 13921 Park Center Road, Ste. 270 Herndon VA 20171 703.657.6900 <a href="http://www.icpi.org">www.icpi.org</a>
GRI	Geosynthetic Research Institute See GSI	IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane Piscataway, NJ 08854-4141 732.981.0060 <a href="http://www.ieee.org">www.ieee.org</a>
		IGCC	Insulating Glass Certification Council PO Box 730 Sackets Harbor, NY 13685 315.646.2234 <a href="http://www.igcc.org">www.igcc.org</a>
		IGMA	Insulating Glass Manufacturers Assoc. 27 N. Wacker Drive, Ste. 365 Chicago, IL 60606-2800 613.233.1510 <a href="http://www.igmaonline.org">www.igmaonline.org</a>

IMI	International Masonry Institute 42 East Street Annapolis, MD 21401 410.280.1305 <a href="http://www.imiweb.org">www.imiweb.org</a>	NACE	National Assoc. of Corrosion Engineers 1440 S. Creek Drive Houston, TX 77084-4906 281.228.6200 <a href="http://www.nace.org">www.nace.org</a>
IPBA	International Pipe Bursting Assoc. Division of NASSCO 410.486.3500 <a href="http://www.nassco.org/about_nassco/an_div_ipba.html">www.nassco.org/about_nassco/an_div_ipba.html</a>	NCAA	National Collegiate Athletic Assoc. 700 W. Washington Street, PO Box 6222 Indianapolis, IN 46206-6222 317.917.6222 <a href="http://www.ncaa.org">www.ncaa.org</a>
KCMA	Kitchen Cabinet Manufacturers Assoc. 1899 Preston White Drive Reston, VA 20191-5435 703.264.1690 <a href="http://www.kcma.org">www.kcma.org</a>	NCMA	National Concrete Masonry Assoc. 13750 Sunrise Valley Drive Herndon, VA 20171-4662 703.713.1900 <a href="http://www.ncma.org">www.ncma.org</a>
LEED	Leadership in Energy and Environmental Design See USGBC	NCRP	National Council on Radiation Protection 7910 Woodmont Avenue, Ste. 400 Bethesda, MD 20814-3095 301.657.2652 <a href="http://www.ncrp.org">www.ncrp.org</a>
MBMA	Metal Building Manufacturers Assoc. 1300 Sumner Avenue Cleveland, OH 44115-2851 216.241.7333 <a href="http://www.mbma.com">www.mbma.com</a>	NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877 301.977.3698 <a href="http://www.nebb.org">www.nebb.org</a>
MFMA	Maple Flooring Manufacturers Assoc., Inc. 111 Deer Lake Road, Ste. 100 Deerfield, IL 60015 888.480.9138 <a href="http://www.maplefloor.org">www.maplefloor.org</a>	NEC	National Electric Code See NFPA
MHIA	Material Handling Industry of America 8720 Red Oak Boulevard, Ste. 201 Charlotte, NC 28217-3992 704.676.1190 <a href="http://www.mhia.org">www.mhia.org</a>	NECA	National Electrical Contractors Assoc. 3 Bethesda Metro Center, Ste. 1100 Bethesda, MD 20814 301.657.3110 <a href="http://www.necanet.org">www.necanet.org</a>
MIA	Masonry Institute of America 22815 Frampton Avenue Torrance, CA 90501-5034 800.221.4000 <a href="http://www.masonryinstitute.org">www.masonryinstitute.org</a>	NEMA	National Electrical Manufacturers Assoc. 1300 N. 17th Street, Ste. 1752 Rosslyn, VA 22209 703.841.3200 <a href="http://www.nema.org">www.nema.org</a>
MIL	Military Specifications DODSSP (Dept. of Defense) Bldg. 4, Section D 700 Robbins Avenue Philadelphia, PA 19111-5098 215.697.2179 <a href="http://www.dsp.dla.mil">www.dsp.dla.mil</a>	NFPA	National Fire Protection Assoc. 1 Batterymarch Park Quincy, MA 02169-7471 617.770.3000 <a href="http://www.nfpa.org">www.nfpa.org</a>
MPI	Master Painters Institute 2800 Ingleton Avenue Burnaby, B.C.Canada V5C 6G7 888.674.8937 <a href="http://www.mpi.net">www.mpi.net</a> <a href="http://www.paintinfo.com">www.paintinfo.com</a>	NFSA	National Federation of State High School Assoc. PO Box 690 Indianapolis, IN 46206 317.972.6900 <a href="http://www.nfhs.org">www.nfhs.org</a>
MSHA	Mine Safety and Health Administration 1100 Wilson Blvd., 21st Floor Arlington, VA 22209-3939 202.693.9400 <a href="http://www.msha.gov">www.msha.gov</a>	NHLA	National Hardwood Lumber Assoc. PO Box 34518 Memphis, TN 38184-0518 901.377.1818 <a href="http://www.nhla.com">www.nhla.com</a>
MSS	Manufacturers Standardization Society of the Valve and Fitting Industry 127 Park St NE Vienna, VA 22180-4602 703.281.6613 <a href="http://www.mss-hq.com">www.mss-hq.com</a>	NIBS	National Institute of Building Sciences 1090 Vermont Avenue NW, Ste. 700 Washington DC 20005-4905 202.289.7800 <a href="http://www.nibs.org">www.nibs.org</a>
MUTCD	Manual on Uniform Traffic Control Devices <a href="http://www.mutcd.fhwa.dot.gov">www.mutcd.fhwa.dot.gov</a>	NIJ	National Institute of Justice 810 Seventh Street NW Washington, DC 20531 202.307.2942 <a href="http://www.ojp.usdoj.gov">www.ojp.usdoj.gov</a>
NAAMM	National Assoc. of Architectural Metal Manufacturers 800 Roosevelt Rd. Bldg. C, Suite 312 Glen Ellyn, IL 60137 630.942.6591 <a href="http://www.naamm.org">www.naamm.org</a>	NIST	NIST - Building and Fire Research Laboratory 100 Bureau Drive, Stop 1070 Gaithersburg, MD 20899-1070 301.975.6478 <a href="http://www.fire.nist.gov">www.fire.nist.gov</a>

NIOSH	National Institute for Occupational Safety and Health Centers for Disease Control and Prevention 1600 Clifton Road Atlanta, GA 30333 800.232.4636 <a href="http://www.cdc.gov/niosh">www.cdc.gov/niosh</a>	NWWDA	National Wood Window and Door Assoc. See WDMA
NLC	National League of Cities 1301 Pennsylvania Avenue NW, Ste. 550 Washington, DC 20004 202.626.3100 <a href="http://www.nlc.org">www.nlc.org</a>	OSHA	U. S. Occupational Safety and Health Administration 200 Constitution Avenue NW Washington, DC 20210 800.321.6742 <a href="http://www.osha.gov">www.osha.gov</a>
NLGA	National Lumber Grades Authority 105 - 13401 108th Avenue Surrey BC V3T 5T3 604.584.2393 <a href="http://www.nlga.org">www.nlga.org</a>	PCA	Portland Cement Assoc. 5420 Old Orchard Road Skokie, IL 60077 847.966.6200 <a href="http://www.cement.org">www.cement.org</a>
NPCA	National Precast Concrete Assoc. 1320 City Center Drive, Suite 200 Carmel, IN 46032 800.366.7731 <a href="http://www.precast.org">www.precast.org</a>	PCI	Precast/Prestressed Concrete Institute 200 W. Adams Street, #2100 Chicago, IL 60606 312.786.0300 <a href="http://www.pci.org">www.pci.org</a>
NPDES	National Pollutant Discharge Elimination System <a href="http://www.epa.gov">www.epa.gov</a>	PCI Midwest	952.806.9997 <a href="http://www.midwestprecast.com">www.midwestprecast.com</a>
NPIC	National Pesticide Information Center Oregon State University 333 Weniger Hall Corvallis, OR 97331-6502 800.858.7378 <a href="http://www.npic.orst.edu">www.npic.orst.edu</a>	PDCA	Painting and Decorating Contractors of America 1801 Park 270 Drive, Ste. 220 St. Louis, MO 63146 800.332.7322 <a href="http://www.pdca.org">www.pdca.org</a>
NRCA	National Roofing Contractors Assoc. 10255 W. Higgins Road Ste. 600 Rosemont, IL 60018-5607 847.299.9070 <a href="http://www.nrca.net">www.nrca.net</a>	PEI	Porcelain Enamel Institute, Inc.P. O. Box 920220, Norcross, GA 30010 PO Box 920220 Norcross, GA 30010 770.676.9366 <a href="http://www.porcelainenamel.com">www.porcelainenamel.com</a>
NSF	NSF International 789 N. Dixboro Road, PO Box 130140 Ann Arbor, MI 48113-0140 800.673.6275 <a href="http://www.nsf.org">www.nsf.org</a>	PPI	Plastics Pipe Institute 105 Decker Court, Ste. 825 Irving TX, 75062 469.499.1044 <a href="http://www.plasticpipe.org">www.plasticpipe.org</a>
NSPE	National Society of Professional Engineers 1420 King Street Alexandria, VA 22314-2794 703.684.2800 <a href="http://www.nspe.org">www.nspe.org</a>	SBIC	Sustainable Buildings Industry Council 1090 Vermont Avenue NW, Ste. 700 Washington, DC 20005 202.289.7800 <a href="http://www.sbicouncil.org">www.sbicouncil.org</a>
NSWMA	National Solid Wastes Management Assoc. 4301 Connecticut Avenue NW, Ste. 300 Washington, DC 20008 800.424.2869 <a href="http://www.environmentalistseveryday.org/about-nswma-solid-waste-management">www.environmentalistseveryday.org/about-nswma-solid-waste-management</a>	RCI	Roof Consultants Institute 1500 Sunday Drive, Ste. 204 Raleigh, NC 27607 800.828.1902 <a href="http://www.rci-online.org">www.rci-online.org</a>
NSSGA	National Stone, Sand & Gravel Assoc. 1605 King Street Alexandria, VA 22314 703.525.8788 <a href="http://www.nssga.org">www.nssga.org</a>	RFCI	Resilient Floor Covering Institute 115 Broad Street, Ste. 201 La Grange GA 30240 706.882.3833 <a href="http://www.rfci.com">www.rfci.com</a>
NTMA	National Terrazzo & Mosaic Assoc. 138 West Lower Crabapple, PO Box 2605 Fredericksburg, TX 78624 800.323.9736 <a href="http://www.ntma.com">www.ntma.com</a>	RMA	Rubber Manufacturers Assoc. 1400 K Street NW, Ste. 900 Washington, DC 20005 202.682.4800 <a href="http://www.rma.org">www.rma.org</a>
NVLAP	National Voluntary Laboratory Accreditation Program 100 Bureau Drive, Stop 1070 Gaithersburg, MD 20899-1070 301.975.6478 <a href="http://www.nist.gov/nvlap">www.nist.gov/nvlap</a>	RPA	Radiant Professional Alliance 18927 Hickory Creek Drive, Ste. 140 Mokena, IL 60448 708.995.3003 <a href="http://www.radiantprofessionalsalliance.org">www.radiantprofessionalsalliance.org</a>
NWFA	National Wood Flooring Association 111 Chesterfield Industrial Boulevard Chesterfield, MO 63005 800.422.4556 <a href="http://www.nwfa.org">www.nwfa.org</a>	SDI	Steel Deck Institute PO Box 25 Fox River Grove, IL 60021 847.458.4647 <a href="http://www.sdi.org">www.sdi.org</a>



SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145-1967 440.899.0010 <a href="http://www.steeldoor.org">www.steeldoor.org</a>	UL	Underwriters' Laboratories, Inc. 2600 N.W. Lake Rd. Camas, WA 98607-8542 877.854.3577 <a href="http://www.ul.com">www.ul.com</a>
SIA	Security Industry Assoc. 635 Slaters Lane, Ste. 110 Alexandria, VA 22314 703.683.2075 <a href="http://www.siaonline.org">www.siaonline.org</a>	USACE	U.S. Army Corps of Engineers Publication Department 2803 52nd Avenue Hyattsville, MD 20781-1102 301.394.0081 <a href="http://www.usace.army.mil">www.usace.army.mil</a>
SIGMA	Sealed Insulating Glass Manufacturers Assoc. See IGMA	USGBC	U.S. Green Building Council 2101 L Street, Ste. 500 Washington DC 20037 800.795.1747 <a href="http://www.usgbc.org">www.usgbc.org</a>
SJI	Steel Joist Institute 234 W. Cheves Street Florence, SC 29501 843.407.4091 <a href="http://www.steeljoist.org">www.steeljoist.org</a>	VSI	Vinyl Siding Institute, Inc. National Housing Center 1201 15th Street NW, Ste. 220 Washington, DC 20005 202.587.5100 <a href="http://www.vinylsiding.org">www.vinylsiding.org</a>
SMACNA	Sheet Metal & Air Conditioning Contractors' National Assoc. 4201 Lafayette Center Drive Chantilly, VA 20150-1209 703.803.2980 <a href="http://www.smacna.org">www.smacna.org</a>	WCLIB	West Coast Lumber Inspection Bureau PO Box 23145 Portland, OR 97281 503.639.0651 <a href="http://www.wclib.org">www.wclib.org</a>
SPRI	Single Ply Roofing Industry 411 Waverley Oaks Road, Ste. 331B Waltham, MA 02453 781.647.7026 <a href="http://www.spri.org">www.spri.org</a>	WCSC	Window Covering Safety Council 355 Lexington Avenue, Ste. 1500 New York NY 10017 212.297.2100 <a href="http://www.windowcoverings.org">www.windowcoverings.org</a>
SSMA	Steel Stud Manufacturer's Assoc. 35 East Wacker Drive, Ste. 850 Chicago, IL 60601-2106 312.224.2570 <a href="http://www.ssma.com">www.ssma.com</a>	WDMA	Window & Door Manufacturer's Assoc. 401 N. Michigan Avenue, Ste. 2200 Chicago, IL 60611 312.321.6802 <a href="http://www.wdma.org">www.wdma.org</a>
SSPC	Steel Structures Painting Council 40 24th Street, 6th Floor Pittsburgh, PA 15222-4656 877.281.7772 <a href="http://www.sspc.org">www.sspc.org</a>	WHI	Warnock Hersey Institute (several locations - now Intertek Testing Service) 7250 Hudson Boulevard, Ste. 100 St. Paul, MN 55128 651.730.1188 <a href="http://www.intertek.com">www.intertek.com</a>
SSPC	Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222-4656 877.281.7772 <a href="http://www.sspc.org">www.sspc.org</a>	WQA	Water Quality Assoc. 4151 Naperville Road Lisle, IL 60532-3696 630.505.0160 <a href="http://www.wqa.org">www.wqa.org</a>
TCNA	Tile Council of North America, Inc. 100 Clemson Research Boulevard Anderson, SC 29625 864.646.8453 <a href="http://www.tileusa.com">www.tileusa.com</a>	WWPA	Western Wood Products Assoc. 522 SW 5th Avenue, Ste. 500 Portland, OR 97204-2122 503.224.3930 <a href="http://www2.wwpa.org">www2.wwpa.org</a>
TIA/EIA	Telecommunications Industry Assoc./ Electronic Industries Alliance 2500 Wilson Boulevard, Ste. 300 Arlington, VA 22201  TIA: 703.907.7700 <a href="http://www.tiaonline.org">www.tiaonline.org</a> EIA: 703.907.7500 <a href="http://www.eia.org">www.eia.org</a>		
TMS	The Masonry Society 105 South Sunset Street, Ste. Q Longmont, Colorado, 80501-6172 303.939.9700 <a href="http://www.masonrysociety.org">www.masonrysociety.org</a>	WDNR	Wisconsin Department of Natural Resources 101 S. Webster, PO Box 7921 Madison, WI 53707 608.266.2621 <a href="http://www.dnr.wi.gov">www.dnr.wi.gov</a>
TPI	Turfgrass Producers International 2 East Main Street East Dundee, IL 60118 800.405.8873 <a href="http://www.turfgrassod.org">www.turfgrassod.org</a>	WisDOT	Wisconsin Department of Transportation 4802 Sheboygan Avenue, PO Box 7916 Madison, WI 53707 <a href="http://www.dot.state.wi.us">www.dot.state.wi.us</a>
UBMA	Used Building Materials Assoc. See BMRA	WEDC	Wisconsin Economic Development Corporation PO Box 7962 Madison, WI 53707 <a href="http://www.wedc.org">www.wedc.org</a>

## 1.04 LIST OF STATE REFERENCES

WMUTCD WI Manual on Uniform Traffic Control Devices  
Division of Transportation  
4802 Sheboygan Avenue  
Madison, WI 53707  
608.266.0150 [www.dot.Wisconsin.gov](http://www.dot.Wisconsin.gov)

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

## SECTION 01 45 10

### QUALITY CONTROL FOR BUILDING CONSTRUCTION

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Administrative and procedural requirements for quality control.
  - 2. Inspection and testing services to assist in determination of work with specifications and regulations.
  - 3. Requirements for Contractor cooperation.
  - 4. Responsibility for payment.
  - 5. Schedule of required tests.
- B. Contractor Responsibility: These required services do not relieve Contractor of responsibility for compliance with any requirements.
- C. Related Sections:
  - 1. Section 01 31 19 - Project Meetings
  - 2. Section 01 74 19 - Construction Waste Management

##### 1.02 REFERENCES

- A. IBC Code: Currently in effect and adopted by state in which Project is located.
- B. Factory Mutual Global:
  - 1. FMG Loss Prevention Data Sheet 1-28
  - 2. FMG 4450 and 4470, Membrane Roofing System Approval Guide
- C. ASTM:
  - 1. D3740 - Minimum Requirements for Agencies Engaged in Testing or Inspection of Soil and Rock
  - 2. E329 - Requirements for Agencies Engaged in Testing or Inspection of Materials Used in Construction

##### 1.03 DEFINITIONS

- A. Quality Control: Inspections, tests, related actions including reports, performed by independent agencies and governing authorities, as well as directed by Contractor.

##### 1.04 SUBMITTALS

- A. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards (NBS) during most recent tour of inspection, with memorandum of remedies of any deficiencies reported by the inspection.
- B. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full-time registered Specialist and responsible officer.
- C. After each inspection and test, submit two written copies of report to Engineer and to Contractor no later than 3 working days after completion of inspection or test. Include:
  - 1. Date issued
  - 2. Project title and number
  - 3. Name of inspector
  - 4. Date and time of sampling or inspection
  - 5. Identification of product and Specifications Section

6. Location in the Project
7. Type of inspection or test
8. Date of test
9. Results of tests
10. Conformance with Contract Documents

D. When requested by Engineer, provide interpretation of test results.

## 1.05 QUALITY ASSURANCE

- A. Laboratory: Select laboratory qualified in accordance with referenced ASTM standard to acceptance of Engineer.
- B. Codes and Standards: Comply with requirements of ASTM D3740 and E329.
- C. Testing:
  1. Contractor shall employ and pay for services of an independent testing laboratory to perform specified inspection and testing.
  2. Employment of testing laboratory shall in no way relieve Contractor of obligation to perform work in accordance with requirements of Contract Documents.
- D. Laboratory Qualifications:
  1. Qualified in accordance with referenced ASTM standard to acceptance of Engineer.
  2. Authorized to operate in state in which Project is located.
  3. Staff: Maintain a full-time registered Engineer Specialist on staff to review services.
  4. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to either National Bureau of Standards (NBS) Standards or accepted values of natural physical constants.

## 1.06 RESPONSIBILITIES

- A. Contractor Responsibility:
  1. Quality control testing or inspections scheduled to be Contractor's responsibility.
  2. Code Compliance Testing: Quality control required by codes or ordinances, or by plan approval authority, made by legally constituted authority unless otherwise provided in Contract Documents.
  3. Verification of conformance of the Work within specified construction tolerances.
  4. Contractor's Convenience Testing.
  5. Notify Engineer and laboratory 24 hours prior to expected time for operations requiring inspections and testing services.
  6. Provide incidental labor and facilities to:
    - a. Provide access to Work to be tested.
    - b. Obtain and handle samples at the Site or at source of products to be tested.
    - c. Facilitate tests and inspections, and storage and curing of test samples.
  7. Coordinate with each independent agency the sequence of activities to accommodate required services with minimum delay in progress of Work and to avoid removing and replacing Work. Schedule times for quality control.
- B. Owner Responsibility: Quality control not specifically indicated as Contractor's responsibility, or to be provided by another identified entity.
- C. Laboratory Responsibility:
  1. Ascertain compliance of materials and mixes with requirements of Contract Documents.
  2. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or Products.
  3. Perform additional inspections and tests required by Engineer.
  4. Limits on Laboratory Authority:
    - a. Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
    - b. Laboratory may not approve or accept any portion of the Work.

- c. Laboratory may not assume any duties of Contractor.
  - d. Laboratory has no authority to stop the Work.
- D. Retest Responsibility:
- 1. Where results of quality control prove unsatisfactory and do not indicate compliance of related Work with requirements of the Contract Documents, retests are responsibility of Contractor, regardless of whether the original test was Contractor's responsibility.
  - 2. Retest of Work revised or replaced by Contractor is Contractor's responsibility, where required tests were performed on original Work.
  - 3. Retesting costs will be deducted from Contract amount by Change Order.
  - 4. Provide 2 retests for each failed test.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 ADJUSTING**

- A. Upon completion of quality control performed on Work, repair damaged Work, restore substrates and finishes to eliminate deficiencies, including deficiencies in visual qualities of exposed finishes. Comply with Contract Document requirements for "Cutting and Patching."

### **3.02 PROTECTION**

- A. Protect Work exposed by or for quality control service activities, and protect repaired Work.

### **3.03 RESPONSIBILITY FOR ADJUSTING AND REPAIR**

- A. Contractor's responsibility, regardless of assignment of responsibility for quality control.

### **3.04 FIELD QUALITY CONTROL**

- A. Testing Agency responsibilities are included in the Street and Utility Quality Control Testing Schedule for general site testing and the Special Structural Testing and Inspection Program Summary Schedule for structural testing.
- B. Special Inspections:
  - 1. Special structural tests and inspections shall be conducted by an Independent Testing Agency, arranged and paid by the Contractor, approved by Owner, with the results being reported to Engineer, Building Inspector, Contractor and Structural Engineer of Record.
    - a. For the items listed in the Special Structural Testing and Inspection Program Schedule herein, see guidelines in IBC Chapter 17.
    - b. Tests and inspections will be paid for by the Contractor, Unless Noted Otherwise.
  - 2. Preconstruction Meeting:
    - a. If requested by Engineer, conduct 1 meeting at Site to review the scope of special structural testing and inspection.
    - b. Comply with requirements of Section 01 31 19.
  - 3. Post Special Structural Testing and Inspection Summary in field office at job Site. Retain all reports submitted by special inspectors for review of the Building Official upon request.
  - 4. The schedule of special structural testing and inspections is attached to this section. In addition, provide testing and inspection of the following:
    - a. Excavating, Filling, Grading:
      - 1) Periodically verify excavations are extended to proper depth and have reached proper material.

- 2) Periodically observe subgrade and verify that site has been prepared properly prior to placement of compacted fill or rock pad.
  - 3) Continuously verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill.
  - 4) Classification and compaction testing for building pads or paved areas: 1 test per 2,500 square feet per 12-inch lift; minimum 3 tests.
  - 5) Foundation wall backfill: 1 test per 100 feet or less of wall length, but no fewer than 2 tests.
  - 6) Footing subgrades: At least 2 tests of each soil stratum to verify design bearing capacities. Refer to "Design Loads" section of General Structural Notes.
  - 7) Utility trenches: 1 test for each 300 feet or less of trench length per lift of backfill material, but no fewer than 2 tests.
  - 8) Roadway grading: 1 test per 2,000 cubic yards (CV) of embankment material.
- b. Proof rolling of parking areas and sidewalks subject to vehicular traffic.
  - c. Secure inspection and acceptance of subgrades and fill layers before subsequent construction is permitted.
- C. Fabricator:
1. The following inspections shall be arranged and paid by the fabricator of products with the results being reported to Engineer, Building Inspector, Contractor and Structural Engineer of record.
    - a. Prestressing reinforcing and tendons for concrete.
    - b. Shop welding of steel fabrications used for structural purposes.

### Street and Utility Quality Control Testing Schedule

Specification Section	Product	Type of Test	Location		Responsibility
			Source	Field	
03 30 00	Concrete Aggregate	Gradation	x		Contractor
31 23 30	Earthwork-Building Pads and Paved Areas	Moisture, Density		x	Ind. Testing Agency
31 23 30	Foundation Wall Backfill	Moisture, Density		x	Ind. Testing Agency
31 23 30	Earthwork – Interior of Structures	Moisture, Density		x	Ind. Testing Agency
31 23 30	Footing Subgrades	Moisture, Density		x	Ind. Testing Agency
31 23 30	Utility Trenches	Moisture, Density		x	Ind. Testing Agency
31 23 30	Roadway Grading	Moisture, Density		x	Ind. Testing Agency
31 23 30	Borrow for Embankment	Moisture, Density		x	Ind. Testing Agency
32 18 20	Concrete Sidewalk	Slump, Air, Temp, Cylinder Compression		x	Ind. Testing Agency
32 16 20	Concrete Curb and Gutter	Slump, Air, Temp, Cylinder Compression		x	Ind. Testing Agency
32 11 14	Subgrade	Test Rolling		x	Contractor
32 11 22	Aggregate Base	Moisture, Density		x	Ind. Testing Agency
32 11 22	Aggregate Base	Gradation	x		Contractor
32 12 16	Asphalt Pavement	Source Quality Control per MnDOT 2360.4	x		Contractor/Fabricator
32 12 16	Asphalt Pavement	Compaction Testing		x	Ind. Testing Agency
32 18 20	Walks - Concrete	Slump, Air, Temperature, Cylinder Compression		x	Ind. Testing Agency
33 11 00	Plant Water Main	Pressure/Leakage		x	Contractor
33 11 00	Potable Water Main	Coliform/Disinfection		x	Contractor
33 31 00	Sanitary Sewer	Infiltration		x	Contractor
33 31 00	Sanitary Sewer	Air/Pressure		x	Contractor
33 31 00	Sanitary Sewer (Flexible Pipe)	Deflection		x	Contractor
33 41 00	Storm Sewer (Flexible Pipe only)	Deflection		x	Contractor
40 23 00	Process Piping	Hydrostatic Leaking		x	Contractor

**SPECIAL STRUCTURAL TESTING AND INSPECTION PROGRAM  
SUMMARY SCHEDULE**

Project Name: Unit Well 19 Treatment System Addition Project Number: MADWU 167818

Location: Madison, Wisconsin

Permit Number (1): \_\_\_\_\_

Technical (2)		Description (3)	Type of Inspector (4)	Frequency (5)	Assigned Firm (6)
Section	Article				
01 42 00	3.01	Leak Testing	Contractor	F5	
01 45 10	3.04	Soils	TA	See 01 45 10	
03 11 00	3.01	Concrete Formwork	SI-S	F3	
03 20 00	3.04	Concrete Reinforcement	SI-S	F3, F4	
03 30 00	3.19	Concrete Placement Techniques	SI-S	F5	
01 45 10	N/A	Concrete Testing	TA	F5	
03 41 00	3.04	Plant-Precast Structural Concrete	SI-S	F7	
03 41 00	3.04	Plant-Precast: Connection Welds	TA	F4	
04 20 00	3.14	Masonry Assemblies: Reinforcement & General Configuration	SI-S	F1, F2	
05 50 00	3.01	Metals: General Configuration	SI-S	F4, F6, F8	
05 31 00	3.01	Steel Decking	SI-S/T	F10	
05 50 00	3.01	Metals: Field Bolting & Welding	TA	F4, F6, F8	
Drawings	N/A	Anchors in Concrete	TA	See structural drawing notes	

**Notes:** This schedule shall be filled out and included in the Special Structural Testing and Inspection Program.

- (1) Permit number to be provided by the Building Official.
- (2) Referenced to the specific technical scope section in the program (specification section).
- (3) Use descriptions per IBC Chapter 17, as adopted by the State Building Code.
- (4) Special Inspector - Technical, Special Inspector - Structural
- (5) Weekly, monthly, per test/inspection, per floor, etc. – See "Frequency" section following this schedule.
- (6) Firm contracted to perform services.

**ACKNOWLEDGMENTS**

Each appropriate representative shall sign below:

Owner: _____	Firm: _____	Date: _____
Contractor: _____	Firm: _____	Date: _____
Architect: _____	Firm: _____	Date: _____
SER: _____	Firm: <u>SEH</u>	Date: _____
SI-S: _____	Firm: _____	Date: _____
SI-T: _____	Firm: _____	Date: _____
TA: _____	Firm: _____	Date: _____
F: _____	Firm: _____	Date: _____

If requested by Engineer of record or Building Official, the individual names of all prospective special inspectors and the Work they intend to observe shall be identified (Use reverse side of form if necessary).

*Legend:* SER = Structural Engineer of Record Agency    SI-S = Special Inspector - Structural    SI-T = Special Inspector - Technical    F = Fabricator    TA = Testing

**Accepted for the Building Department by** \_\_\_\_\_ **Date** \_\_\_\_\_



## 1. FREQUENCY

If conflicting information is provided in technical specification sections, the more stringent requirement governs.

### A. CATEGORIES

- F1.** Mortar tests as set forth in Sections 10 and 11 of ASTM C270, for each mortar type used.
- F2.** Test grout as set forth in ASTM C1019 - Sampling and Testing Grout. Test at least one specimen for each day's pouring or for each 75 cubic yards of concrete or fraction thereof poured each day.
- F3.** The inspector shall periodically see all formwork, reinforcing steel, pre-stressing tendon, and anchor bolts prior to concrete placement to inspect for conformance with the drawings.
- F4.** The inspector shall see all structural steel and reinforcing steel field welds prior to application of finishes to inspect for conformance with the approved plans. If applicable, the inspector shall request the testing agency perform Ultrasonic Testing on 50 percent of all full penetration field welds for the project. If the failure of welding test is 25 percent of all tests performed, 100 percent of all full penetration field welds shall be tested.
- F5.** Concrete Placement: Continuous Inspection - Inspector to review placement of all cast-in-place concrete. Periodically verify use of required design mix. Periodically inspect for maintenance of specified curing temperature and techniques. Test shall be made by a Level 1 Technician as certified by ACI.
- a. Concrete Specimens:
- 1) Compression Strength Testing: The method of making cylinders, storage and testing shall be in accordance with ASTM Specification C31, latest edition. Record any deviations from the requirements of ASTM C31 in the test report.
    - a) Cast 4 six inch cylinders per set (or an additional cylinder if four inch cylinders are used):
      - (1) One at 7 days for information
      - (2) Two at 28 days for acceptance
      - (3) One for hold (test at 56 days if desired by Engineer, or if other tests were lower than specified).
    - b) Conduct at least 1 strength test for each 75 yards or fraction thereof for each mixture design placed in any 1 day.
    - c) Furnish a copy of the test results to Engineer as soon as available.
    - d) Field cure cylinders (2 per set) to check concrete strength prior to critical shoring removal as recommended in Section 03 30 00.
    - e) Acceptance test results shall be the average strengths of the 2 specimens tested at 28 days.
    - f) Conduct load test on test cores of concrete that fail to meet the specified strength, in accordance with ASTM C42.
    - g) Failure to meet strength requirements of the cores, shall be a cause for rejection by Engineer.
    - h) The cost of remedial measures required due to test failures shall be paid for by the Contractor.
  - 2) Standard Field Tests to be performed on fresh concrete for the first truck and every third truck thereafter (1<sup>st</sup>, 4<sup>th</sup>, 7<sup>th</sup>, etc.) or when a change in properties is noticed, at the final location (test after pump, not at truck):
    - 1) Concrete Slump Tests:
      - a) Testing agency will determine slump of concrete from each truck in accordance with ASTM Specification C143, latest edition.
      - b) If slump exceeds maximum allowed, remove batch from work and dispose of off-site.
      - c) Test slump at end of conveying system.
    - 2) Concrete Air Content Tests:
      - a) Testing agency will determine air content of concrete from each truck in accordance with ASTM Specification C231, latest edition.

- b) Air content shall be tested at end of conveying system.
- 3) Concrete Temperature:
  - a) Testing agency will determine temperature of concrete from each truck in accordance with ASTM C1064.
  - b) Test temperature at end of conveying system.
- c. Leak Testing Watertight Structures:
  - 1) Refer to section 01 42 00 Watertightness Testing

**F6.** All bolts shall be checked for snug tight condition.

**F7.** Periodically inspect erection of precast concrete members. Field welds subject to Section F4.

**F8.** Periodic inspection of steel erection for conformance with the drawings.

**F9.** Periodic inspection of metal trusses for conformance with drawings including installation of hurricane clips and bracing.

**F10.** Periodic inspection of metal deck as follows:

1. Field welding of deck in accordance with AWS D1.3, SDI C, SDI NC, and SDI RD.
2. Installation of mechanical fasteners in accordance with SDI C, SDI NC, SDI RD, and manufacturer's instructions.
3. Steel deck installation in accordance with the construction documents, installation drawings, shop drawings, design documents and applicable referenced standards.

**F11.** Periodic inspection of bearing and shearwall construction for conformance with the drawings including installation of hold-down anchors.

**F12.** Periodic inspection of wood trusses for conformance with drawings including installation of hurricane clips and bracing.

**END OF SECTION**

**SECTION 01 51 36**  
**TEMPORARY WATER**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Availability of Water for Construction.

**1.02 DESCRIPTION**

- A. Water is available from the Utility of Madison.
- B. Utility will not charge for a reasonable amount of water supplied.
- C. Water shall be obtained from approved Utility hydrant.
- D. Piping shall be the responsibility of the Contractor.
- E. Keep water use to minimum and consistent with needs.
- F. Service Connection:
  - 1. Contact Madison Water Utility (MWU) Engineering Section to have Hydrant RPZ Valve installed. 608.266.4646.
  - 2. Contractor must protect RPZ valve from freezing and/or damage.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

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## SECTION 01 52 13

### FIELD OFFICE

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes furnishing and maintaining field office for use by Contractor, subcontractors, and Engineer during construction operations.
- B. Related Sections:
  - 1. Section 01 11 00 - Summary of Work
  - 2. Section 01 71 13 - Mobilization
- C. Basis of Payment: Incidental

##### 1.02 DESCRIPTION

- A. Basic Requirements:
  - 1. Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations, with steps and landings at entrance doors.
  - 2. Minimum 8-foot wide and 7-foot ceiling height.
  - 3. Minimum 120 square feet of usable space.
  - 4. Weatherproof and insulated.
  - 5. Finished interior walls.
  - 6. Heating and air conditioning system
  - 7. Telephone service
  - 8. Electrical service
  - 9. Lighting: 50-foot C at desktop height and exterior lighting at entrance doors.
  - 10. Internet access
- B. Furnishings:
  - 1. Desk and chair.
  - 2. Flat surface large enough to examine Construction Documents.
  - 3. Drawing rack.
  - 4. Conference table and chairs to seat at least 6 persons.
  - 5. Telephone.
  - 6. Answering machine.
  - 7. Wastebasket.
  - 8. Potable water supply.
  - 9. Fire extinguisher.
  - 10. Six adjustable-band protective helmets for visitors.
  - 11. One 10-inch outdoor weather thermometer.

##### 1.03 LOCATION

- A. Locate to provide convenient access to construction Site and as provided on Drawings or determined in field by Engineer.
- B. Subject to Owner's approval.
- C. Existing facilities shall not be used for field offices.

#### **1.04 SCHEDULE**

- A. Provide facility and services upon commencement of construction or within 10 days after date fixed in Notice to Proceed.
- B. Remove building, utilities, and foundation upon completion and acceptance of Work. Restore area.

#### **1.05 MAINTENANCE**

- A. Maintain, clean, and repair field office and services to ensure proper working order throughout the duration of construction operations.
- B. Maintain approach walks free of mud, water, and snow.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 52 19**

**TEMPORARY SANITARY FACILITIES**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Provide temporary closet or privy.
- B. Provide heater throughout cold weather months (October-April) or at the sole discretion of the Owner/Engineer.
- C. Maintain throughout Project duration.
- D. Type and location subject to Engineer's approval.
- E. Remove upon completion of Project.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

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## SECTION 01 55 10

### ACCESS ROADS AND PARKING AREAS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Access roads.
  - 2. Parking.
- B. Related Sections:
  - 1. Section 01 11 00 - Summary of Work
  - 2. Section 01 31 13 - Coordination
  - 3. Section 01 57 00 - Temporary Controls

#### PART 2 PRODUCTS

##### 2.01 MATERIALS

- A. Temporary Construction - Contractor's option.
- B. Earthwork, base, paving and topping that will become permanent construction - as specified.

#### PART 3 EXECUTION

##### 3.01 ACCESS ROADS

- A. Construct and maintain temporary access roads from public thoroughfares to serve construction area, of a width and load bearing capacity to provide unimpeded traffic for construction purposes.
- B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
- C. Extend and relocate as Work progress requires.
- D. Provide detours as necessary for unimpeded traffic flow.
- E. Locate as indicated on Drawings or approved by Engineer.
- F. Provide unimpeded access for emergency vehicles.
- G. Maintain 20-foot width driveways with turning space between and around combustible materials.
- H. Provide means of removing mud from vehicle wheels before entering streets.

##### 3.02 PARKING

- A. Arrange for or provide temporary parking areas to accommodate use of construction personnel.
- B. Designated existing on-site streets and driveways may be used for construction traffic.
  - 1. Tracked vehicles not allowed.
  - 2. Do not allow heavy vehicles or construction equipment in parking areas.

- C. When Site space is not adequate, provide additional off-site parking.
- D. Locate as indicated or approved by Engineer.

### **3.03 PERMANENT PAVEMENTS AND PARKING FACILITIES**

- A. Prior to Substantial Completion, base for permanent roads and parking areas may be used for construction traffic.
- B. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.
- C. Permanent parking structures may not be used by construction personnel without permission of Owner.

### **3.04 MAINTENANCE**

- A. Maintain traffic and parking areas in a sound condition free of excavated material, construction equipment, products, mud, snow, and ice.
- B. Maintain existing and permanent paved areas used for construction.
  - 1. Promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

### **3.05 REMOVAL, REPAIR**

- A. Remove temporary materials and construction when permanent paving is usable or at Substantial Completion.
- B. Repair facilities damaged by use to original or specified condition.

**END OF SECTION**

## SECTION 01 55 25

### MAINTENANCE OF TRAFFIC

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes procedures and equipment for safely maintaining and controlling traffic within and near the Site and on the project detour during construction.
- B. Basis of Payment: Incidental

##### 1.02 REFERENCES

- A. AASHTO - Guide for Selecting Locations and Designing Traffic Barriers
- B. ANSI/ISEA 107 - 2004 Standard for Protective Clothing
- C. Traffic Control Treatment of Longitudinal Joints and Edge Drop-offs in Work Zones (enclosed)
- D. WisDOT Facilities Development Manual (including all current, applicable Standard Detail Drawings)
- E. WisDOT Standard Specifications for Highway and Structure Construction, 2003 Edition (including all supplements) including:
  - 1. Section 104.6 - Roadway Maintenance and Traffic Control
  - 2. Section 107.8 - Public Convenience and Safety
  - 3. Section 643 - Traffic Control
- F. WMUTCD

##### 1.03 DEFINITIONS

- A. Long Term Restriction: A traffic restriction or lane closure which is in effect during construction without regard to the time restrictions stated in 1.07 B.
- B. Short Term Restriction: A traffic restriction or lane closure which is in effect only during the Contractor's work hours and is consistent with the time restrictions stated in 1.07 B.

##### 1.04 SUBMITTALS

- A. Pre-Construction:
  - 1. Traffic Control Plan as detailed in 1.07 C.
  - 2. Names, addresses and phone numbers of 2 local persons who will respond to requests for maintenance as detailed in 1.08 D.
- B. Permits: Obtain any and all permits necessary from the State and the County to allow for signing, barricading and work within the State or County right-of-way as necessary to complete the project.

##### 1.05 QUALITY ASSURANCE

- A. Operations: Conduct all operations in accordance with the WMUTCD.
- B. Flaggers:
  - 1. Provide qualified certified flaggers familiar with applicable traffic laws and regulations and properly trained in the responsibilities of traffic control, including provisions spelled out in the WMUTCD.

2. Provide properly deputized flaggers to direct and control traffic around or through a traffic control device.
3. Flaggers shall be properly clothed and equipped, including shirt or blouse, slacks or trousers, sturdy shoes, hard hat, vest (reflectorized at night), a 2-way radio, and an approved "Stop-Slow" paddle or standard.
4. Uniformed off duty police/patrol officers using hand signals may be used as flaggers. They shall be equipped with a vest and hard hat during flagging operations.

## **1.06 SITE CONDITIONS**

- A. Parking of Contractor/Worker Vehicles:
1. Do not park vehicles in a manner or location which:
    - a. Interferes with traffic flow.
    - b. Conflicts with resident or consumer parking.
    - c. Obstructs any traffic control device.
    - d. Lies within the project limits unless so approved by Engineer.

## **1.07 SEQUENCING AND SCHEDULING**

- A. Closure and Detour Requests:
1. Submit request for short term lane closure to Engineer at least 48 hours prior to time of closure, consistent with the provisions detailed in 1.07 B.
  2. Submit request to close street and divert traffic to Engineer at least 3 working days prior to time of closure.
  3. Authority to divert or close shall be subject to Engineer's approval.
  4. Provide notice for all closures and detours as stated in 3.01 A.
  5. Contractor may request that through traffic be detoured consistent with the provisions and restrictions found elsewhere in this section of the Special Provisions. The request shall contain all information needed to justify the request and select the routes to be established. If arrangements can be made that are satisfactory to the agencies having jurisdiction over the roads to be used, the contracting authority may then, at its sole discretion, establish an approved detour subject to the following conditions:
    - a. Contractor, at Contractor's expense, shall design, provide, install, maintain, and remove all the necessary traffic control devices on the detour roads.
    - b. Contractor shall reimburse the City for all expenses incurred in maintaining and restoring the detour roads, except for snow removal.
    - c. Contractor shall fulfill their obligations for maintenance of local traffic by furnishing, placing, and maintaining all traffic control devices and other traffic protection measures required of him on the roads undergoing improvements.
- B. Restrictions:
1. Work which interferes with traffic operations described in this specification shall not be performed during the following times:
    - a. From 6:00 a.m. to 8:00 a.m. - Monday thru Friday inclusive.
    - b. From 4:00 p.m. to 6:00 p.m. - Monday thru Friday inclusive.
    - c. From 12:00 noon on the day before to 9:00 a.m. the day following any consecutive combinations of Saturday, Sunday and legal holiday.
  2. Lane closures will not be permitted during inclement weather or when Engineer determines that such closure will be a hazard to traffic.
  3. Nighttime Work:
    - a. Nighttime work shall be approved in advance by Engineer.
    - b. Adequate lighting shall be provided as necessary during nighttime construction (supplementing or replacing existing street lighting) so that the work, personnel, equipment, traffic control devices and flaggers are visible to motorists.
    - c. All workers shall wear reflectorized jumpsuits during nighttime construction.
  4. Maintain all in-place railroad tracks, crossings and signals at all times unless otherwise permitted by the railroad agency and Engineer.
  5. Notify proper railroad agency prior to beginning any work at or adjacent to railroad property.

6. Streets which shall not be closed or restricted at any time (all traffic lanes and shoulders kept completely open):
  - a. University Ave
  - b. Highway 14
7. Streets which shall not be closed to traffic at any time, but on which short-term lane closures may be utilized:
  - a. Lake Mendota Drive
  - b. Eagle Heights

(Note: Contact proper agency and Engineer at least 72 hours prior to restricting traffic on these roadways.)

8. Maintain 1 lane of traffic in each direction at all times, unless a short-term lane closure has been approved by Engineer, on the following streets:
  - a. Lake Mendota Drive
  - b. Eagle heights
9. Lane widths shall be 12 feet (minimum).
10. Lanes shall be continuous throughout the project, and may be adjacent to each other or separated.
11. Traffic shall be maintained on in-place, temporary or permanent roadway, or on a combination of these.
12. Flagpersons shall be utilized on any roadway that is restricted to 1 lane for traffic, except as approved by Engineer or as noted below:
  - a. N/A
13. Short-term lane closures, short-term spot road closures, or restrictions of traffic to 1 lane may be utilized on the following streets:
  - a. Lake Mendota Drive
  - b. Eagle Heights
14. The following streets may be closed to traffic:
  - a. N/A
15. Furnish, install and maintain all proper signing, flagpersons (as appropriate) and warning devices in order to:
  - a. Close or restrict traffic on a roadway.
  - b. Provide adequate detour information.
  - c. Protect the work, the workers and the motorist.
  - d. Be consistent with (or similar to) the requirements of the "Signing and Detour Plan" enclosed in the Plans.
  - e. Inform the motorist of pending construction and direct the motorist through the work zone.
16. Maintain access to individual residences and businesses fronting the following roadways at all times, unless otherwise approved by the affected property owner and Engineer:
  - a. Lake Mendota Drive
  - b. Eagle Heights
17. Access to individual properties fronting a roadway under construction may be maintained on in-place or permanent roadway, or via an Engineer approved gravel surface.
18. Traffic may be restricted on any street requiring milling, miscellaneous road work, and/or surfacing, subject to the following:
  - a. Local traffic shall be maintained during edge milling operations. ROAD WORK AHEAD signs shall be placed in advance of the milling operations and flagpersons provided as necessary to guide traffic through the construction area.
  - b. Streets may be closed or have access restricted to traffic for full-width milling and for surfacing, consistent with the hours in Section 1.07.B.1 or local traffic may be maintained consistent with the provisions above.
  - c. Milling, miscellaneous road work and surfacing operations shall be coordinated with street reconstruction to afford local residents access to the vicinity of their homes, consistent with other portions of these Special Provisions.
  - d. Any drop-off where traffic will cross from or to the in-place surface or from or to the milled surface shall be tapered and/or chamfered so as to provide for safe passage of traffic.
  - e. ROUGH ROAD AHEAD and BUMP signs shall be placed at locations determined by Engineer after milling operations have been completed.

- f. Do not mill any notches for surfacing tapers until immediately prior to paving, except that (as approved by Engineer) notches may be milled if a temporary bituminous taper is installed and maintained until the surfacing taper is installed.
- 19. Do not close or restrict traffic on 2 adjacent parallel streets at the same time.
- 20. Provide for protection of traffic from open excavations as described in 3.02.B.2.
- 21. Conduct operations to allow continual fire and police access to all areas within the project.
- 22. The previous restrictions may be modified as necessary to insure safe traffic operations.

C. Traffic Control Plan:

- 1. Content:
  - a. Use the traffic control plan included in the Plans, or submit an alternate traffic control plan for approval within 10 days after the contract award and 5 days prior to initiating any construction.
  - b. As construction progresses, provide an updated traffic control plan for the next 2 weeks of work to Engineer (on a weekly basis) for approval and/or suggested modifications.
  - c. Information to be included in the plan:
    - 1) Schedule in bar graph form indicating all construction tasks and planned sequence of construction operations
    - 2) Proposed street closures or restrictions and estimated dates.
    - 3) Provisions for routing detoured traffic.
    - 4) Signs and devices to be used.
  - d. The traffic control plan shall reflect the restrictions detailed in Paragraph B.
- 2. Acceptance:
  - a. Each traffic control plan is subject to acceptance, rejection or suggested revision by Engineer.
  - b. No construction operations may begin without the complete approval of the plan.
- 3. Revisions: All revisions to the traffic control plan are subject to the approval of the Engineer.

**1.08 MAINTENANCE**

A. Responsibility:

- 1. Maintain all traffic control devices, on a 24 hour basis, throughout the term of the contract, including work suspensions.
- 2. Repair or replace as necessary:
  - a. Devices that are damaged or moved.
  - b. Lights that cease to function properly.
  - c. Barricade weights that are damaged or fail to stabilize the barricade.

B. Inspection:

- 1. Check all devices twice daily, including once at the end of the work day.
- 2. Conduct 1 night (after work hours) inspection of all devices per week.
- 3. Immediately correct all deficiencies in alignment, visibility and reflectivity.

C. Traffic Control Checklist:

- 1. Complete the checklist contained in the attachments of these Special Provisions each day of each week that traffic control devices are being used on the project.
- 2. Submit completed checklist to Engineer (or designated representative) each day at a mutually agreeable time.
- 3. Failure to submit the checklist by the agreed upon time will be considered "noncompliance" in maintaining traffic control devices and may be subject to the daily charge set forth under Section 108.11 of the WisDOT Standard Specifications for Highway and Structure Construction.
- 4. Copies of the traffic control devices checklist will be provided by contacting Engineer.

D. Notice:

- 1. Furnish names, addresses, and phone numbers of 2 local persons who will respond to requests for maintenance to the following:
  - a. Engineer
  - b. City/Police Department
  - c. Madison Water Utility

- d. WisDOT Dispatcher
  - 2. Provide a means of receiving maintenance requests on a 24 hour basis.
  - 3. Respond to all maintenance requests within 2 hours.
- E. Failure to respond to maintenance requests will result in the work being completed by the Owner with twice the cost thereof being deducted from any monies due the Contractor.

## **PART 2 PRODUCTS**

### **2.01 EQUIPMENT**

- A. Signs:
  - 1. Provide all required signs in accordance with the WMUTCD, the WisDOT Facilities Development Manual, and as approved by Engineer.
  - 2. All signs shall be fabricated of either steel or aluminum.
- B. Barricades:
  - 1. Provide 8-foot, Type III barricades in accordance with the current WisDOT S.D.D. 15C 2-3.
  - 2. Provide flashers on all barricades.
- C. Barriers: Provide temporary portable precast concrete barriers in accordance with the current WisDOT S.D.D. 14B 7-9a.
- D. Drums: Provide drum-like channelizers in accordance with the WMUTCD (Part 6).
- E. Ballast:
  - 1. Sandbags will be the only acceptable weight to stabilize traffic control devices.
  - 2. During freezing conditions, the sand for bags and impact barrels shall be mixed with a deicer to prevent the sand from freezing.
  - 3. Sandbags shall be placed on each foot of traffic control device to be established.
- F. Miscellaneous:
  - 1. Store the following devices at a convenient location within the project limits of each portion of the project for use in an emergency, as approved by Engineer:
    - a. At least 5 extra Type I barricades with flashers.
    - b. At least 5 extra Type III barricades.
    - c. At least 10 extra drums.
  - 2. No direct compensation will be made for furnishing, storing and erecting these traffic control devices.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Advance Notice:
  - 1. Provide minimum 72 hour notice for all closures and detours to the following:
    - a. Engineer
    - b. WisDOT Dispatcher
    - c. Wisconsin State Patrol
    - d. City Police Department
    - e. City Fire Department
    - f. Local Ambulance Dispatcher
    - g. Madison Water Utility
    - h. Dane County Highway Department
    - i. Postal Service
  - 2. Provide minimum 48 hour notice for all closures and detours to all affected residences and businesses, for when closures and detours will occur and what their duration will be.

3. Meet with businesses affected by each restriction of access and coordinate work to allow for deliveries to be made to each affected business during construction.

B. In-place Facilities:

1. Signs:
  - a. Do not remove signs unless authorized by Engineer.
  - b. Carefully remove and store designated signs and posts for reinstallation.
  - c. Replace signs and posts damaged or lost during removal or construction.
  - d. Carefully remove and deliver signs and posts to the appropriate agency (WisDOT, City of Madison, Dane County) as directed by Engineer.
  - e. Provide flaggers as directed when "STOP" or other prohibition signs are removed.
  - f. Relocate or temporarily mount and maintain required regulatory, warning, guide, and street name signs along streets that remain open to traffic.
  - g. Reinstall all signs not being replaced in accordance with the WMUTCD.
2. Mailboxes:
  - a. Prior to proceeding with any work, relocate any mail and other delivery boxes, within the construction area and as designated by Engineer, to a location which will allow delivery during construction.
  - b. Mailboxes so designated by Engineer shall be removed and placed on the homeowner's property. (Homeowner is responsible for postal service during construction).
  - c. Temporary mailbox banks may be utilized in accordance with the following:
    - 1) Temporary mailbox banks shall be accessible to postal service and postal recipient at all times.
    - 2) Numerous mailbox banks may be utilized to minimize distances from postal recipients.
    - 3) Materials used to construct temporary mailbox banks shall be the Contractor's.
  - d. Property owner's posts, cross members and mailboxes not used during temporary relocation shall be properly stored by the Contractor.
  - e. Notification of the postal service, delivery services and postal recipient shall be made 5 days prior to relocation.
  - f. Postal service and other affected delivery services shall approve all locations and installations.
  - g. If postal delivery is not achieved, work shall stop immediately and remain stopped until the situation is corrected.
  - h. Following construction, reinstall all mail and other delivery boxes in convenient locations and in compliance with USPS regulations.
  - i. Replace any box or supporting member that is damaged during construction.
  - j. Permanent installation shall be acceptable to the postal service, the delivery service and property owner.
3. Traffic Signals:
  - a. During several stages of construction, the sequence of construction and traffic control plan will require modifications to the in-place signal systems noted above.
  - b. Sequence of construction shall identify modifications to be made.
  - c. Contractor shall ensure that a traffic control signal system is in operation at each intersection at all times, except as otherwise approved by Engineer.
  - d. An all-way stop condition may be installed at the above-mentioned intersection if the following conditions are met:
    - 1) The all-way stop condition is part of a suitable traffic plan or sequence of construction for the project approved by Engineer.
    - 2) All signal cable, signal equipment and signal hardware required for the signal system is available either on the job site or in the normal stock of the Contractor and available for immediate installation.
    - 3) Roadway construction activities require removal of portions of the existing traffic signal system.
    - 4) Stop (R1-1) signs shall be 48 inches by 48 inches high intensity grade reflective sheeting and shall be placed on the left and right side of all approaches to the intersection.
    - 5) 48 inches by 48 inches Stop Ahead (W3-1a) signs, with orange warning flags, shall be installed on both sides of all approaches to the intersection at the locations directed by Engineer.



- e. Under no conditions will the all-way stop condition be allowed during the winter or other nonconstruction periods.
  - f. In-place equipment not being modified, replaced or abandoned shall be maintained and protected in-place as approved by Engineer.
  - g. Contact the proper agency at least 72 hours prior to need for modifications to signal system.
  - h. The proper agency may authorize the Contractor to make modifications, or may require that agency personnel be present to make modifications.
4. Pavement Markings:
- a. Remove all pavement markings that conflict with temporary traffic control operations in accordance with WisDOT 646.3.4.
  - b. Removal and replacement of permanent pavement markings shall be considered as incidental to Traffic Control, unless otherwise approved by Engineer.

### 3.02 OPERATIONS

#### A. Installation of Devices:

- 1. Provide, locate and maintain all traffic control devices in accordance with the contract documents and the approved traffic control plan.
- 2. Devices shall not interfere with in-place devices that will not be removed.
- 3. Provide minor modifications and field adjustments as directed at no additional cost to accommodate special conditions or situations which may occur.
- 4. Signs shall be mounted on posts driven into ground at proper height and lateral offset, or, if not possible, signs shall be maintained on portable supports or barricades.
- 5. Signs shall not be mounted on metal drums.
- 6. Placement of all signs and barricades shall proceed in the direction of the flow of traffic.
- 7. Cover all traffic control devices which may be inconsistent with traffic patterns.

#### B. Traffic Protection:

- 1. General:
  - a. Do not deposit or store materials or park equipment on or adjacent to any roadway open to traffic that will interfere with the safe flow of traffic.
  - b. Provide traffic barriers for any obstruction placed within the "clear zone" as defined by the AASHTO Guide for Selecting Locations and Designing Traffic Barriers.
  - c. Keep roadways which are open to traffic free from earth materials and debris.
  - d. During construction, provide devices to protect traffic and pedestrians from drop-offs, openings, falling objects, splatter or other hazards.
- 2. Open Excavations/Drop-Offs Adjacent to the Traveled Roadway:
  - a. Schedule operations so as to minimize traffic exposure to uneven lanes, milled edges and edge drop-offs.
  - b. Provide and maintain appropriate traffic control in accordance with the "Traffic Control Treatment of Longitudinal Joints and Edge Drop-offs in Work Zones" sheets of these Special Provisions.
  - c. Close a traffic lane, auxiliary lane or shoulder on any road open to traffic (in accordance with 1.07B) when construction operations cause a drop-off greater than 4 inches adjacent to that lane or shoulder, unless adequately protected by traffic barrier.
  - d. Concrete or utility repairs of less than 50 feet in length and open for seven days or less do not require that the adjacent lane or shoulder be closed to traffic.
  - e. Sign and delineate any drop-off (caused by construction operations) of less than 4 inches as shown in the WMUTCD.
  - f. When excavations on roadways open to traffic exceed 1-foot in depth:
    - 1) Provide continuous portable concrete barriers for the entire length of the excavation.
    - 2) Include suitable end treatment consisting of tapered barrier sections, impact attenuators or a combination thereof.
    - 3) Place warning lights at minimum 50-foot intervals.
- 3. In lieu of precast concrete barrier, barrels and barricades may be used during construction, as approved by Engineer, provided that:
  - a. Construction work is actively done in or directly adjacent to the excavation.
  - b. Workers are present.
  - c. It is daylight hours, or, if nighttime hours, there is additional lighting of the open excavation.

- d. Traffic is in a single lane (alternating) or a single lane in each direction with parking removed.
  - e. The barrels or barricades can be set outside the minimum widths required for traffic and at intervals as directed by the Engineer.
- C. Pedestrian Access and Traffic:
- 1. Provide continuous access to all adjacent residences and businesses.
  - 2. Provide temporary boardwalk where in-place sidewalk is removed.
  - 3. When access to business entrances is prohibited, coordinate with business owners to provide protection and direction for alternate entrances.
  - 4. Provide signs, barricades, flasher, snow fence or other devices as required to protect pedestrians adjacent to the work.
  - 5. Cover newly poured concrete sidewalk with plywood after curing compound is applied to provide access at business entrances.
- D. Removal of Devices:
- 1. When signs are removed, sign posts shall also be removed as soon as possible.
  - 2. Removal of signs and barricades shall start at the end of construction areas and proceed toward oncoming traffic, unless otherwise directed by Engineer.

### 3.03 FIELD QUALITY CONTROL

- A. At least 24 hours prior to construction and upon request, present all traffic control devices intended for use on the project to Engineer to ensure conformance with the WMUTCD.
- B. Replace any device which is found to be defective.
- C. Replace reflective material (on both new and used traffic control devices) whose effectiveness, in Engineer's opinion, has been substantially reduced from traffic or other causes.
- D. Keep all traffic control signs and devices furnished in a legible condition (including by removing any grime deposited on devices by traffic, natural causes or by the nature of the work being performed).
- E. Relocate any traffic control device that is misplaced due to Contractor or Subcontractor operations.

### 3.04 SCHEDULES

- A. Final Bituminous Course:
  - 1. A separate plan for traffic control may be prepared for the installation of the final bituminous binder and wear courses.
  - 2. Plan does not have to adhere to the above restrictions, but shall be prepared in detail and submitted to Engineer for approval.
  - 3. Engineer will determine the viability of the planned sequence and may accept, reject or suggest alterations to this separate plan.
  - 4. Do not begin installation of final bituminous binder and wear course, crosswalks or pavement markings without complete approval of this separate plan by Engineer, or without inclusion of these elements in the above-referenced sequence of construction.
- B. Restoration of Roadway Surfaces:
  - 1. Restore all roadway surfaces and areas disturbed within 30 calendar days time after completion of utility work.
  - 2. Time elapsed between initial construction disruption to completion of bituminous base course shall not exceed 40 calendar days.
  - 3. A roadway will be considered "restored" when all backfilling and compaction is complete and a bituminous surface suitable to handle vehicular traffic has been installed; except as otherwise permitted by Engineer.

### **3.05 ADDITIONAL TRAFFIC CONTROL DEVICES**

- A. General Requirements:
  - 1. In addition to the traffic control devices approved by Engineer prior to each stage of construction, or as shown in the Traffic Control Layouts, Engineer may require more traffic control as traffic conditions warrant.
  - 2. Furnish and install the additional traffic control devices ordered by Engineer.
  - 3. The devices shall be installed and maintained in a functional and legible condition at all times.
  
- B. Method of Measurement:
  - 1. Measure flashers, barricades, reflectorized drums, and standard signs by the number of individual units of each type, multiplied by the number of calendar days each unit is in service.
  - 2. Measure special construction signs by the face area thereof furnished and installed as specified.
  
- C. Basis of Payment:
  - 1. Payment for additional traffic control devices of each type, at the appropriate predetermined unit price set forth by and between Engineer and Contractor, shall be compensation in full for all costs of furnishing, installing, maintaining, and subsequently removing and disposing of the devices.

**END OF SECTION**

Traffic Control Treatment of  
Longitudinal Joints and  
Edge Drop-offs in Work Zones

**GUIDELINES**

THESE GUIDELINES ARE INTENDED TO INCREASE TRAFFIC SAFETY USING TRAFFIC CONTROL DEVICES, SAFETY RELATED APPURTENANCES, AND CONSTRUCTION TECHNIQUES FOR UNEVEN LANES, MILLED EDGES, AND EDGE DROP-OFFS THAT OCCUR IN HIGHWAY WORK ZONES. THE BEST WAY TO INCREASE TRAFFIC SAFETY IS TO MAKE EVERY ATTEMPT TO MINIMIZE EXPOSURE TO UNEVEN LANES, MILLED EDGES, AND EDGE DROP-OFFS; HOWEVER, IT IS REALIZED THAT THIS IS OFTEN NOT POSSIBLE OR FEASIBLE. ONLY WHEN UNEVEN LANES, MILLED EDGES, OR EDGE DROP-OFFS ARE DEEMED NECESSARY, SHALL THE APPROPRIATE PORTION(S) OF THESE GUIDELINES BE APPLIED TO ENHANCE TRAFFIC SAFETY.

APPROPRIATE UNEVEN LANE WARNING SIGNS OR SHOULDER WARNING SIGNS SHALL BE REPEATED AFTER EACH INTERSECTION.

MAXIMUM WARNING SIGN SPACING SHALL BE:

- A - 1 MILE WHEN THE SPEED LIMIT IS GREATER THAN 30 MPH AND
- B - 1/4 MILE WHEN THE SPEED LIMIT IS 30 MPH OR LESS.

WHEN SPACE PERMITS, MINIMUM WARNING SIGN SIZE SHALL BE:

- A - 48 INCHES x 48 INCHES WHEN THE SPEED LIMIT IS GREATER THAN 30 MPH AND
- B - 36 INCHES x 36 INCHES WHEN THE SPEED LIMIT IS 30 MPH OR LESS.

1. FOR DROP-OFFS OF 1-1/2 INCHES OR LESS, APPROPRIATE WARNING SIGNS SHALL BE PROVIDED:
2. FOR DROP-OFFS GREATER THAN 1-1/2 INCHES UP TO 4 INCHES:
  - A - THE EDGE SHALL BE TAPERED AND COMPACTED AT A RATE OF 3:1 AND APPROPRIATE WARNING SIGNS SHALL BE PROVIDED; OR
  - B - IF THE TAPER IS NOT PROVIDED, TRAFFIC SHALL NOT BE PERMITTED TO CROSS THE DROP-OFF AND THAT PORTION OF THE ROADWAY SHALL BE CLOSED TO TRAFFIC WITH THE APPROPRIATE WARNING SIGNS AND DEVICES.
3. FOR DROP-OFFS GREATER THAN 4 INCHES UP TO 12 INCHES:
  - A - THE EDGE SHALL BE TAPERED AND COMPACTED AT A RATE OF 6:1 AND APPROPRIATE WARNING SIGNS SHALL BE PROVIDED, (6:1 TAPER SHALL NOT BE USED AS A TRAFFIC CARRYING LANE);
  - B - THE EDGE SHALL BE TAPERED AND COMPACTED AT A RATE OF 3:1, TRAFFIC SHALL NOT BE ALLOWED TO CROSS THE DROP-OFF, AND THAT PORTION OF THE ROADWAY SHALL BE CLOSED TO TRAFFIC WITH APPROPRIATE WARNING SIGNS AND CHANNELIZING DEVICES; OR
  - C - IF A TAPER IS NOT PROVIDED, THE TRAFFIC OR AUXILIARY LANE ADJACENT TO THE DROP-OFF SHALL BE CLOSED TO TRAFFIC WITH THE APPROPRIATE WARNING SIGNS AND CHANNELIZING DEVICES OR A POSITIVE BARRIER, SUCH AS A PORTABLE PRECAST CONCRETE BARRIER, SHALL BE PROVIDED TO PREVENT TRAFFIC FROM CROSSING THE DROP-OFF.
4. FOR SHOULDER EDGE DROP-OFFS:
  - A - 0-2 FOOT SHOULDER WIDTH AND A 0-12 INCH DROP-OFF; USE GUIDELINES AS SHOWN
  - B - 2-8 FOOT SHOULDER WIDTH AND A 0-4 INCH DROP-OFF; INSTALL EDGELINE OR USE GUIDELINES AS SHOWN
  - C - 8 FOOT OR GREATER SHOULDER WIDTH AND A 0-4 INCH DROP-OFF; NO TRAFFIC CONTROL REQUIRED
  - D - GREATER THAN 2 FOOT SHOULDER WIDTH AND A 4-12 INCH DROP-OFF; USE GUIDELINES AS SHOWN
5. DROP-OFFS GREATER THAN 4 INCHES ADJACENT TO TRAFFIC CARRYING LANES ARE PERMITTED WITHOUT TAPERS OR POSITIVE BARRIERS FOR:
  - A - PROJECTS WITHIN URBAN AREA WHEN THE SPEED LIMIT IS 30 MPH OR LESS; OR
  - B - SHORT TERM (7 CALENDAR DAYS OR LESS) CONCRETE OR UTILITY REPAIR, LESS THAN 50 FEET IN LENGTH WHEN THE SPEED LIMIT IS GREATER THAN 30 MPH.
6. AT NO TIME SHALL THERE BE MORE THAN ONE UNEVEN LANE CONDITION BETWEEN THE TRAFFIC CARRYING LANES WHICH INCLUDE AUXILIARY LANES, TURN LANES, AND RAMP ACCESS OR EGRESS AREAS. WEATHER PERMITTING, ALL EXPOSED UNEVEN LANES CONDITIONS WITHIN THE TRAFFIC CARRYING LANES SHALL BE "MATCHED" WITHIN 24 HOURS.
7. MILLING OPERATIONS SHALL BE REQUIRED TO COMPLETE THE FULL WIDTH OF THE SECTION UNDER CONSTRUCTION AT THE END OF EACH WORK PERIOD.

Longitudinal Joints and  
Edge Drop-offs in Work Zones

**GUIDELINES**  
CONT.

Appropriate uneven lane warning signs or shoulder warnings signs shall be repeated after each intersection.

Maximum warning sign spacing shall be:

- a - 1 mile when the speed limit is greater than 30 mph, and
- b - 1/4 mile when the speed limit is 30 mph or less.

When space permits, minimum warning sign size shall be:

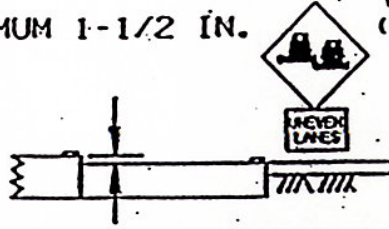
- a - 48 inches x 48 inches when the speed limit is greater than 30 mph, and
- b - 36 inches x 36 inches when the speed limit is 30 mph or less.

TRAFFIC CONTROL TREATMENT OF  
LONGITUDINAL JOINTS AND  
EDGE DROP-OFFS IN WORK ZONES

**UNEVEN LANES**

MAXIMUM 1-1/2 IN.

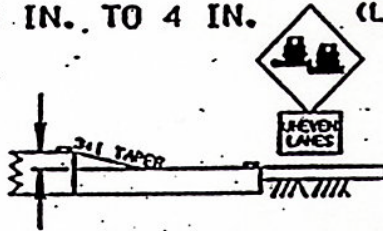
W20-X14  
(L OR R)



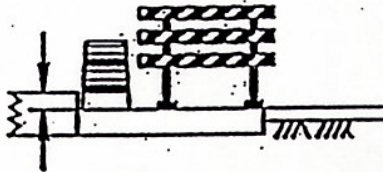
UNEVEN LANES - WITH TAPER

1-1/2 IN. TO 4 IN.

W20-X14  
(L OR R)



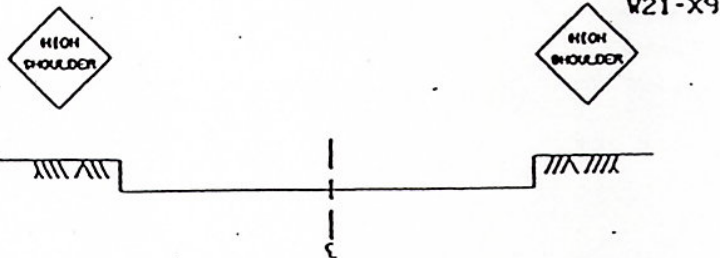
1-1/2 IN. TO 4 IN.



LANE SHALL BE CLOSED WITH APPROPRIATE LANE CLOSURE FROM APPENDIX B. CHANNELIZING DEVICES AT A MAXIMUM OF 100 FT. SPACING AND A TYPE III BARRICADE EVERY 1000 FT.

NOTE: FOR DIVIDED HIGHWAYS, USE SIGNS ON RIGHT AND LEFT SIDE. SIGN SEQUENCE SHOWN FOR ONE DIRECTION ONLY; OTHER DIRECTION SHALL BE IDENTICAL.

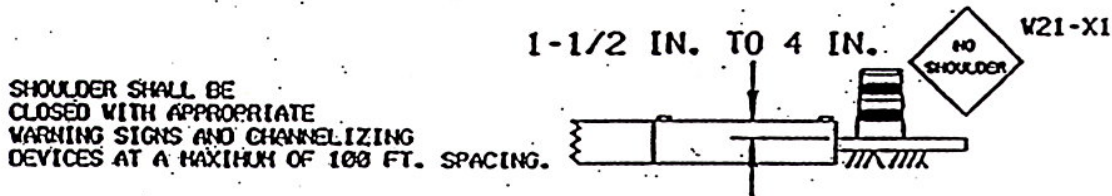
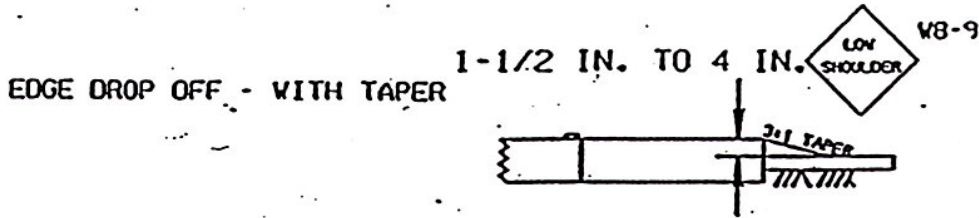
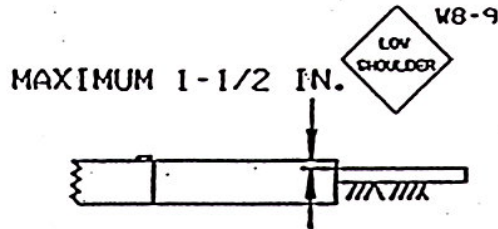
**MILLED EDGE**



NOTE: MILLED EDGES SHOULD BE TREATED WITH TAPERS, CHANNELIZERS, AND SIGNING AS SHOWN ON EDGE DROP-OFF DETAILS.

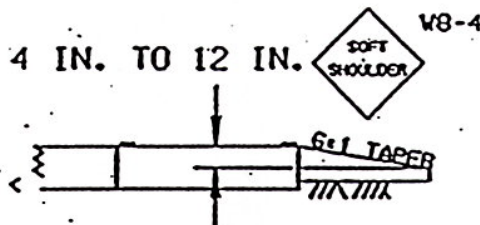
TRAFFIC CONTROL TREATMENT OF  
LONGITUDINAL JOINTS AND  
EDGE DROP-OFFS IN WORK ZONES

EDGE DROP OFF



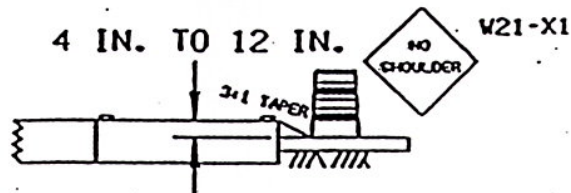
EDGE DROP-OFF WITH TAPER  
(SHOULDER - OPEN)

THIS CONDITION WILL NOT BE PERMITTED UNLESS THE 6:1 SLOPE IS COMPACTED SO THAT A VEHICLE MAY SAFELY DRIVE ONTO IT WITHOUT LOSING CONTROL AND IN THE OPINION OF THE ENGINEER THERE ARE NO OTHER HAZARDOUS CONDITIONS.

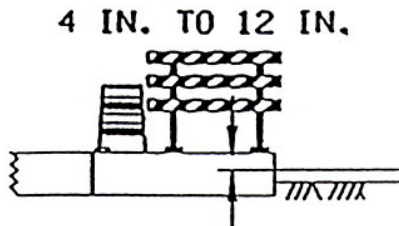


EDGE DROP-OFF WITH TAPER  
(SHOULDER - CLOSED)

SHOULDER SHALL BE CLOSED WITH APPROPRIATE WARNING SIGNS AND CHANNELIZING DEVICES AT A MAXIMUM OF 100 FT. SPACING



ADJACENT LANE SHALL BE CLOSED WITH APPROPRIATE LANE CLOSURE LAYOUT SHOWN IN APPENDIX B. CHANNELIZING DEVICES TO BE AT A MAXIMUM OF 100 FT. SPACING AND TYPE III EVERY 1000 FT.



NOTE: SIGNS ARE REQUIRED ONLY ON THE SIDE OF THE ROAD THAT IS AFFECTED BY CONSTRUCTION (EXCEPT SIGNS THAT ARE FOR A LANE CLOSURE ON DIVIDED HIGHWAYS).

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## SECTION 01 57 00

### TEMPORARY CONTROLS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Drainage control.
  - 2. Dust control.
  - 3. Erosion and sediment control.
  - 4. Noise control.
  - 5. Pollution control.
  - 6. Barriers.
  - 7. Protection:
    - a. Shoring and bracing.
    - b. Enclosures.
    - c. Installed work.
    - d. Security.
    - e. Fire protection.
  - 8. Site cleaning.
- B. Related Sections:
  - 1. Section 01 11 00 - Summary of Work
  - 2. Section 01 52 13 - Field Office
  - 3. Section 01 55 10 - Access Roads and Parking Areas
  - 4. Section 01 57 00 – Temporary Controls
  - 5. Section 01 57 12 - Erosion Control
  - 6. Section 01 57 19 - Air, Land, and Water Pollution
  - 7. Section 31 11 00 - Clearing and Grubbing
  - 8. Section 31 23 30 Excavation, Backfilling and Compacting

##### 1.02 QUALITY ASSURANCE

- A. Regulatory Requirements: As a minimum, comply with local, state, and federal requirements.

##### 1.03 DRAINAGE CONTROL

- A. Reference: See Section 31 23 30.
- B. Maintain excavations free of water.
  - 1. Grade Site to drain.
  - 2. Provide, operate, and maintain pumping equipment.
  - 3. Protect Site from puddling or running water.

##### 1.04 DUST CONTROL

- A. Reference: See Section 01 57 00 and 01 57 19.
- B. Execute Work by methods to minimize raising dust from construction operations.
- C. Provide positive means to prevent airborne dust from dispersing into atmosphere.
- D. Where existing equipment is in use, provide adequate means of protecting equipment from dust arising from the Work.

- E. Where new equipment has been placed into service, provide adequate means of protecting equipment from dust arising from the Work.

### **1.05 EROSION AND SEDIMENT CONTROL**

- A. Reference: See Section 01 57 12.
- B. Prevent erosion and sedimentation:
  - 1. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas.
  - 2. Minimize amount of bare soil exposed at one time.
  - 3. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
  - 4. Use selective placement at construction fill and waste areas to avoid erosive surface silts or clays.
  - 5. Periodically inspect earthwork to detect evidence of erosion and sedimentation.
  - 6. Promptly apply corrective measures.

### **1.06 NOISE CONTROL**

- A. Comply with local noise ordinances.
- B. Avoid use of tools or equipment that produce harmful noise.
- C. Restrict use of noise-making tools and equipment to hours of use that will minimize noise complaints from persons or businesses near Site.
- D. Provide noise suppression barriers or equipment used to perform the Work.

### **1.07 POLLUTION CONTROL**

- A. Reference: See Section 01 57 19.
- B. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

### **1.08 BARRIERS**

- A. Reference: See Section 31 11 00.
- B. Provide barriers as required to:
  - 1. Prevent public entry to construction areas.
  - 2. Protect existing facilities, designated plantings and trees, and adjacent properties from damage from construction activities.
- C. Construction:
  - 1. Type: Contractor's option
  - 2. Height: 6-foot.
  - 3. Gates: Equip with vehicular and pedestrian gates with locks.
- D. Access: Provide barricades and covered walkways as required for public rights-of-way, for public access to, and emergency egress from existing buildings.

### **1.09 PROTECTION**

- A. Shoring and Bracing:
  - 1. Provide temporary shoring, bracing, and protection as required for installation and protection of Work.
  - 2. Ensure adequacy of such items.
  - 3. Repair or replace damaged Work occasioned by inadequate temporary supports.

4. Leave temporary shoring and bracing in place until permanent construction is complete to point where installed Work is properly supported.
- B. Enclosures:
1. Exterior:
    - a. Provide temporary weather-tight closures of openings in exterior surfaces to:
      - 1) Provide acceptable working conditions and protection for materials.
      - 2) To allow for temporary heating.
  2. Interior:
    - a. Provide temporary partitions and ceilings as required to:
      - 1) Separate Work areas from Owner-occupied areas.
      - 2) Prevent penetration of dust and moisture into Owner-occupied areas.
      - 3) Prevent damage to existing areas and equipment.
    - b. Construction:
      - 1) Framing and sheet materials with closed joints and sealed edges at intersections with existing surfaces.
- C. Installed Work:
1. Provide temporary protection for installed products; control traffic in immediate area to minimize damage.
  2. Provide protective coverings at walls, projections, jambs sills, and soffits of openings; protect finished floors and stairs from traffic, movement of heavy objects.
  3. Prohibit traffic and storage on waterproofed and roofed surfaces or on lawn and landscaped areas.
- D. Security:
1. Provide security program and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, and theft.
  2. Provide doors in enclosures with self-closing hardware and locks.
  3. Provide temporary locks for doors installed in Work.
- E. Fire Protection:
1. Fire extinguishers shall be non-freeze type such as A-B-C rated dry chemical of not less than 10-pound capacity.
  2. Provide and maintain in working order during entire construction period, a minimum of 1 fire extinguisher in construction area and 1 in field office.
  3. Contractors who maintain enclosed sheds on the premises shall provide and maintain, in an accessible location, a minimum of 1 non-freezing type extinguisher in each shed.
  4. Each Contractor using open flame (i.e., welding or soldering) shall have a 10-pound minimum extinguisher within closest practical distance.

## **1.10 SITE CLEANING**

- A. Keep Site neat, clean, free of debris.
- B. Prevent papers, cardboard or other debris from blowing around Site or onto adjacent property.
- C. Contractor shall provide and pay for dumpsters for collection of trash.
- D. Control accumulation of waste materials and rubbish. Collect and dispose of all trash from the Site at regular intervals.
- E. Separate and recycle applicable materials.

## **1.11 CONCRETE WASTE CONTROL**

- A. Concrete waste resulting from the Work shall be disposed of in the designated concrete washout area as identified in the Drawings.
- B. Washout area shall include a controlled waste box. Ground-based washout will not be permitted.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

## ENTSECTION 01 57 12

### EROSION CONTROL

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes prevention and control of soil erosion and siltation and the resultant turbidity of streams, lakes, and impoundments.
- B. Related Sections:
  - 1. Section 01 57 12 - Erosion Control
  - 2. Appendix attached to this Section – City of Madison Erosion Control Permit
- C. Basis of Payment:
  - 1. All expenses shall be borne by the Contractor with no direct compensation.
  - 2. Failure to comply with established erosion control measures will result in withholding of progress payments by the Owner.

##### 1.02 SUBMITTALS

- A. Proposed schedule for accomplishment of Work within, adjacent to, or affecting surface water.
- B. Erosion control schedule.
- C. Submit within 30 days of Notice of Award and prior to the Preconstruction Conference; or as required by City of Madison permit attached to this Section

##### 1.03 QUALITY ASSURANCE

- A. Obtain all necessary permits from the responsible regulatory agencies for temporary erosion control measures not shown on the Drawings.
- B. “Wisconsin Site Best Management Handbook” by the WDNR Bureau of Wastewater Management will be the basis for all erosion control on this Project.
- C. Comply with all terms and conditions in the City of Madison Erosion Control Permit.

##### 1.04 REFERENCES

- A. WisDOT 628 - Erosion Control
- B. City of Madison Erosion Control Permit – Attached in the Appendix to this Section.

##### 1.05 SEQUENCING AND SCHEDULING

- A. Construct drainage facilities and turf establishment concurrently with earthwork operation.
- B. Complete construction and finishing operation on a drainage area basis to minimize erosion.
- C. Incorporate erosion control measures at the earliest practical time during construction.
- D. Install erosion control measures as directed prior to the disturbance of in-place ground cover in critical areas that are tributary to public waters.

## **1.06 MAINTENANCE**

- A. Maintain all erosion control facilities to provide proper function throughout the Project.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.01 CONSTRUCTION REQUIREMENTS**

- A. Reporting and record keeping documentation is required per the City of Madison Permit.
- B. Shape exposed soil areas to permit runoff with minimal erosion.
- C. Install safeguards to prevent water pollution from haul roads, work platforms or other temporary construction facilities.
- D. Restore all plant, equipment or other supplementary operation sites to prevent siltation and erosion.
- E. Repair any offsite damage resulting from failure to install or maintain erosion control measures.

**END OF SECTION**



City of Madison Engineering Division

EROSION CONTROL PERMIT

Permit Number: ENG100-2023-06741

City Engineering: (608) 266-4751

Location of Work: 2526 Lake Mendota DR

Parcel: 070916100997


Permittee: Mark Mickelson

Telephone: (414) 949-8947

Email: mmickelson@sehinc.com

Owner: UNIV OF WIS REGENTS

Telephone:

FEE SCHEDULE		APPROVALS		
Total Disturbed Area Fee	127.25	Plan Review:	MAE	
Full Plan Base Fee	200.00	Issuance:	MAE	
<b>Total Fee Amount</b>	<b>327.25</b>			
<hr/>				
Total Invoiced Amount	327.25			
Paid	327.25			
Balance Due	0.00			

Call 811 or (800) 242-8511  
(262) 432-7910  
(877) 500-9592 (emergency only)

PROPOSED WORK: Unit Well 19 Treatment System Addition

Project Description:

Permit Type: Full Plan

Construction Start Date: 3/1/2024

Permit Expiration Date: 10/31/2025

Seed Sod Restore Date: 6/1/2025

USLE Rate: 2.1

Total Disturbed Area: 25,450

EC Checklist Attached

EC Plan Attached

Pumping Plan Attached

FOR CITY OF MADISON USE ONLY: APPROVED

Megan Eberhardt

10/04/2023

- Erosion Control Permit Reviewer

Date

Full Plan

See page two of this permit for Permit Conditions and Requirements.



## City of Madison Engineering Division

# EROSION CONTROL PERMIT

Permit Number: ENG100-2023-06741

City Engineering: (608) 266-4751

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**Location of Work:** 2526 Lake Mendota DR

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**Telephone:** (414) 949-8947

**Email:** mmickelson@sehinc.com

**Owner:** UNIV OF WIS REGENTS

**Telephone:**

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### Permit Conditions and Requirements:

Failure to abide by any of the following permit conditions will be considered a violation of the City's Erosion Control Ordinance (MGO Ch. 37) and can result in the issuance to the permittee and/or the property owner of Official Notices, citations, and/or referral to the City Attorney for resolution of non-compliance.

Erosion & Sediment Control Measures are to be installed prior to any land disturbance activities.

Within ten (10) days of the completion of the project or site stabilization the applicant shall submit an Erosion Control Notice of Termination (ECNOT). The ECNOT should be sent to the administrative authority that initially approved your permit.

The Erosion Control Permit applicant shall conduct a pre-construction meeting attended by a Professional Engineer responsible for initial implementation certification of the erosion control plan. The Professional Engineer shall document and submit minutes of this meeting to City Engineering.

A Professional Engineer currently licensed in the State of Wisconsin shall certify the initial installation and implementation of the measures shown on the approved erosion control plan. Documentation on the City's Installation Certification form shall be submitted to the administrative authority within one (1) week of the installation. The certification form can be found on the City's webpage at <http://www.cityofmadison.com/engineering/Permits.cfm>.

As part of the Erosion Control Permit requirements this construction project requires erosion control inspections and reporting by the permittee (or by their authorized inspector). Inspections shall be conducted a minimum of once per week and also after every 24-hour rain event of 0.5" or more precipitation. The results of these inspections shall be entered on the City's permit and inspection tracking system.

Dust Control, if applicable shall be provided, per WDNR Conservation Practice Standard 1068.

Trench Dewatering, if applicable shall be provided, per WDNR Conservation Practice Standard 1061.

All BMP's installed for erosion control shall be in accordance with the applicable WDNR Conservation Practice Standards found at: [http://dnr.wi.gov/topic/stormwater/standards/const\\_standards.html](http://dnr.wi.gov/topic/stormwater/standards/const_standards.html)



## SECTION 01 57 19

### AIR, LAND, AND WATER POLLUTION

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes general requirements for the control of pollution from construction sites and related activities.
- B. Related Sections:
  - 1. Section 01 57 12 - Erosion Control
  - 2. Section 31 25 10 - Temporary Erosion Control

##### 1.02 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Conduct all operations to prevent, control and abate the pollution of air, land and water in accordance with the rules, regulations and standards adopted and established by the following agencies:
    - a. City of Madison
    - b. University of Wisconsin
    - c. Wisconsin Department of Natural Resources
    - d. U.S. Army Corps of Engineers

##### 1.03 SCHEDULING

- A. Schedule and conduct all operations to minimize soil erosion and prevent siltation and the resultant turbidity of public waters.

#### PART 2 PRODUCTS

Not Used

#### PART 3 EXECUTION

##### 3.01 PREPARATION

- A. Review all local conditions and regulations pertaining to air and land pollution prior to commencing operations.

##### 3.02 WORK IN WELLHEAD PROTECTION AREA

- A. Take necessary precaution to protect Well No. 19 from outside contamination.
- B. All fuels and harmful chemicals stored on site shall be stored in a secondary containment.
- C. Prevent fuel or harmful chemicals from spilling on ground.
- D. Do not discharge concrete truck or other rinse waters to the ground on the site. Provide containment and disposal off site for concrete washout materials including truck rinse water and concrete solids. Contain and dispose off site or in approved dumpsters.

### **3.03 PROTECTION OF WATERS**

- A. Prevent pollution of flowing or impounded waters from particulate or liquid matter that may be harmful to fish and wildlife or detrimental to public use.
- B. Remove sediment from aggregate wash operations by filtration or settlement prior to discharge into public waters.
- C. Do not discharge wash water or waste from concrete mixing operations into live streams, storm sewers, or any other ground surface or conduit that empties ultimately to a surface or ground water. See 3.02 D.

**END OF SECTION**

## SECTION 01 60 00

### PRODUCT REQUIREMENTS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Administrative and procedural requirements governing:
    - a. Products.
    - b. Delivery, storage and handling.
  - 2. The following is not included in this section: Product Substitution Procedures (Section 01 25 13).

##### 1.02 PRODUCT DEFINITIONS

- A. Products:
  - 1. Unless indicated otherwise, the term "products" represents new material, machinery, components, equipment, fixtures, and systems forming the Work.
  - 2. Does not include machinery and equipment used for preparation, fabrication, conveying, or erection of the Work.
- B. Named Products: Items identified by manufacturer's product name, including make or model designation, indicated in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
- C. Materials: Products that are substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed as part of the Work.
- D. Equipment: A product with operational parts, whether motorized or manually operated, that requires service connections such as wiring or piping.

##### 1.03 PRODUCT QUALITY ASSURANCE

- A. Source Limitations: To the fullest extent possible, provide products of the same kind, from a single source.
- B. Limited Quantities:
  - 1. When specified products are available only from sources that do not or cannot produce a quantity adequate to complete Project requirements in a timely manner, consult with Engineer for a determination of the most important product qualities before proceeding.
  - 2. Qualities may include attributes relating to:
    - a. Visual appearance.
    - b. Strength.
    - c. Durability.
    - d. Compatibility.
  - 3. When a determination has been made, select products from sources that possess these qualities to the fullest extent possible.

##### 1.04 PRODUCT REQUIREMENTS

- A. Minimum Requirements: Comply with specifications and referenced standards.
- B. Product Provision: Provide products complete with all accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and for the intended use and effect.

- C. Components: Items required to be supplied in quantity within a specification section shall be the same and shall be interchangeable.
- D. Compatibility of Options: When Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
- E. Existing Products: Do not use materials and equipment removed from existing premises, except as specifically required or permitted by Contract Documents.
- F. Nameplates:
  - 1. Except for required labels and operating data, do not attach or imprint manufacturer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.
  - 2. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on an accessible surface that is not conspicuous.
  - 3. Equipment Nameplates:
    - a. Provide permanent nameplate on each item of service-connected or power-operated equipment.
    - b. Locate on an easily accessible surface that is inconspicuous in occupied spaces.
    - c. Provide the following information and other essential operating data on nameplate:
      - 1) Name of product and manufacturer.
      - 2) Model and serial number.
      - 3) Capacity.
      - 4) Speed.
      - 5) Ratings.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. General Requirements:
  - 1. Deliver, store and handle products in accordance with the manufacturer's recommendations.
  - 2. Schedule and coordinate the delivery of materials to ensure personnel and equipment will be available at the Site.
  - 3. Sequence deliveries to avoid delays but minimize on-site storage.
  - 4. Prevent damage, deterioration, soiling, and loss, including theft.
  - 5. Repair or replace damaged materials at no additional cost to Owner.
- B. Packing and Shipping: Deliver products to the jobsite in manufacturer's sealed containers bearing the manufacturer's name and brand, and appropriate UL labels for fire hazard and fire resistance classification.
- C. Acceptance at Site:
  - 1. Promptly inspect shipments to ensure that:
    - a. Products comply with requirements.
    - b. Quantities are correct.
    - c. Products are undamaged.
  - 2. Replace damaged or defective materials.
- D. Storage and Protection:
  - 1. Store with manufacturer's seals and labels intact and legible.
  - 2. Store sensitive products in weather-tight, climate-controlled enclosures.
  - 3. Cover products subject to deterioration with impervious sheet covering, providing ventilation to avoid condensation.
  - 4. For exterior storage of fabricated products, place on sloped supports, above ground.
  - 5. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
  - 6. Provide off-site storage and protection when Site does not permit on-site storage or protection.
  - 7. Protect stored materials from damage by adjacent work, falling debris, or equipment.

8. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

## 1.06 PRODUCT SELECTION

- A. Product selection is governed by the Contract Documents, and governing regulations by previous project experience.
- B. Proprietary Specification Requirements: Where only a single product or manufacturer is named, provide the product indicated. No substitutions will be permitted.
- C. Semi-Proprietary Specification Requirements:
  1. Where 2 or more products or manufacturers are named, provide 1 of the products indicated. No substitutions will be permitted.
  2. Where products or manufacturers are specified by name, accompanied by the term "or equal," or "or approved equal", comply with Section 01 25 13 or other Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.
  3. Contractors and suppliers will be expected to provide the specified product unless prior approval is received from Engineer's office in sufficient time to notify Bidders through addendum.
- D. Descriptive Specification Requirements: Where specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements.
- E. Performance Specification Requirements:
  1. Where specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated.
  2. Manufacturer's recommendations may be contained in published product literature, or by the manufacturer's certification of performance.
  3. General overall performance of a product is implied where the product is specified for a specific application.
- F. Compliance with Standards, Codes and Regulations: Where the specifications only require compliance with an imposed code, standard or regulation, select a product that complies with applicable standards, codes and regulations.
- G. Visual Matching:
  1. Where specifications require matching an established sample, Engineer's decision will be final on whether a proposed product matches satisfactorily.
  2. Where no product available within the specified category matches satisfactorily but complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product, or for noncompliance with specified requirements.
- H. Visual Selection: Where specified product requirements include the phrase "*...as selected from manufacturer's standard colors, patterns, textures...*" or a similar phrase, select a product and manufacturer that comply with other specified requirements. Engineer will select the color, pattern and texture from the product line selected.

## PART 2 PRODUCTS

Not Used

## **PART 3 EXECUTION**

### **3.01 CLEANING AND PROTECTION**

- A. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

**END OF SECTION**

**SECTION 01 71 23**  
**FIELD ENGINEERING**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Field engineering provided by Contractor.
  - 2. Site layout.
  - 3. Staking.
  - 4. Quantity surveys and computations.
- B. Related Sections:
  - 1. Section 01 11 00 - Summary of Work
- C. Method of Measurement: All field engineering will be considered incidental.

**1.02 SUBMITTALS**

- A. Submit name and qualifications of surveyor that will perform Work.
- B. Submit log or other records of all survey Work completed.
- C. Submit copies of measurement and calculations for quantity surveys.

**1.03 QUALITY ASSURANCE**

- A. All Work in this Section shall be under the direction of a surveyor registered in the State in which the Project is located.

**1.04 SITE CONDITIONS**

- A. Benchmarks and control points are identified on the Drawings.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 EXAMINATION**

- A. Verify locations of control points prior to start of Work.
- B. Relate information given on the Drawings to existing Site conditions.
- C. Promptly advise Engineer of any discrepancies.

**3.02 PREPARATION**

- A. Protect and preserve all benchmarks and control points.

- B. Advise Engineer of the required relocation of any reference points due to grade changes or other reasons.
- C. Replace dislocated reference points based on original survey control.

### 3.03 SURVEY REQUIREMENTS

- A. Staking:
  - 1. Establish locations, layouts, lines and elevations by instrumentation and similar methods for the following improvements:
    - a. Backwash Tank overflow elevation.
  - 2. Tolerances:
    - a. Horizontal Distances: 1/7500
    - b. Horizontal Angles: 0 degrees - 00 minutes - 00 feet - 01 inches
    - c. Elevation:  
 $0.050ft.x\sqrt{length (miles)}$
  - 3. Maintain log or record book indicating all Work completed for review and submittal.
- B. Quantity Surveys:
  - 1. Perform surveys to determine final quantities for the following improvements:
    - a. None.
  - 2. Submit copies of all measurements and calculations to Engineer for review.

**END OF SECTION**



## SECTION 01 75 00

### STARTING AND ADJUSTING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Starting systems.
  - 2. Testing, adjusting, and balancing.
  - 3. Demonstration and instructions.
- B. Related Sections:
  - 1. Section 01 33 00 - Submittal Procedures
  - 2. Section 01 77 00 - Closeout Procedures
  - 3. Section 01 78 23 - Operation and Maintenance Data
  - 4. Individual Technical Sections

##### 1.02 GENERAL FACILITY OPERATIONAL AND COMMISSIONING REQUIREMENTS

- A. Final commissioning period
- B. Prior to Madison Water Utility accepting beneficial Occupancy of the Facility (Regular operation and use), Contractor must demonstrate successful facility operation for 7-continuous days.
- C. Successful facility operation shall be defined as:
  - 1. Operation of the facility at the designed production rates and backwash intervals, supplying acceptably treated water to the ground storage reservoir and then from the ground storage reservoir to the distribution system via high service pumping as required.
  - 2. Proper operation of the new backwash reclaim system.
  - 3. Proper operation of the new chemical feed systems.
  - 4. Proper operation of the system and controls shall include new SCADA and control systems.
  - 5. System must not experience any major system alarms, malfunctions or failures
- D. Any deviation from successful operation defined above will result in the re-start of the seven (7) day commissioning period.
- E. Contractor shall have a representative available at all times (24 hours a day, seven days per week) to address any system failures or SCADA alarms
- F. Upon successful 7-day facility operation, MWU staff will continue the operation of the facility.
- G. Upon occurrence of MWU operation, Contractor shall have a representative available at all times (24 hours a day, seven days per week) to address any system issues or alarms.
- H. The Consulting Engineer may also at the same time provide a representative to assist the contractor and Utility staff with start-up and optimization of the treatment equipment, process flow meters, and SCADA operation.

##### 1.03 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment systems.
- B. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

- C. Verify wiring and support components for equipment are complete and tested.
- D. When specified in individual specification sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- E. Submit a written report in accordance with Section 01 33 00 that equipment or system has been properly installed and is functioning correctly.

#### **1.04 TESTING, ADJUSTING, AND BALANCING**

- A. Contractor will appoint, employ, and pay for services of an independent firm, approved by Owner, to perform testing, adjusting and balancing.
- B. Reports will be submitted by the independent firm to Engineer indicating:
  - 1. Observations and results of tests.
  - 2. Compliance or non-compliance with manufacturer's requirements and with the requirements of the Contract Documents.

### **PART 2 PRODUCTS**

Not Used

### **PART 3 EXECUTION**

#### **3.01 DEMONSTRATION AND INSTRUCTIONS**

- A. A manufacturer's representative who is knowledgeable about the project shall meet with Owner's personnel prior to date of final inspection to provide instruction in proper operation and maintenance:
  - 1. Utilize operation and maintenance manuals as basis for instructions.
  - 2. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
  - 3. Include a detailed review of the following items:
    - a. Maintenance manuals.
    - b. Record documents.
    - c. Spare parts and materials.
    - d. Tools.
    - e. Lubricants.
    - f. Fuels.
    - g. Identification systems.
    - h. Control sequences.
    - i. Hazards.
    - j. Cleaning.
    - k. Warranties.
    - l. Maintenance agreements and similar continuing commitments.
  - 4. Manufacturer's representative shall demonstrate the following procedures to Owner's personnel prior to date of final inspection:
    - a. Startup.
    - b. Shutdown.
    - c. Emergency operations.
    - d. Noise and vibration adjustments.
    - e. Safety procedures.
    - f. Economy and efficiency adjustments.
    - g. Effective energy utilization.
    - h. Troubleshooting.
    - i. Maintenance.

- B. Prepare and insert additional data in operations and maintenance manuals if need for additional data becomes apparent during instructions.

**END OF SECTION**

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## SECTION 01 77 00

### CLOSEOUT PROCEDURES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Administrative and procedural requirements for contract closeout, including:
  - 1. Submittals.
  - 2. Inspection procedures.
  - 3. Warranties.
  - 4. Record document submittals.
  - 5. Final cleaning.
  - 6. Pest control.
  
- B. Related Sections:
  - 1. Section 01 78 23 - Operation and Maintenance Data
  - 2. Specific requirements for individual units of work are included in appropriate technical sections.

##### 1.02 BENEFICIAL OCCUPANCY

- A. Completion Dates
  - 1. Deadline for beneficial occupancy will be August 30, 2025.
  - 2. Failure to meet beneficial occupancy requirements will result in liquidated damages.
  
- B. Complete the following before requesting Engineer's inspection for certification of beneficial occupancy:
  - 1. Assure the following:
    - a. All equipment signed off from the vendor
    - b. All equipment has been tested, adjusted and properly started and commissioned.
    - c. Facility commissioning is successful (see section 01 75 00)
    - d. All inspections complete (see below)
    - e. MWU has unrestricted use of entire facility.
    - f. MWU is able to operate the complete facility as designed and is able to provide safe and reliable water supply to the water distribution system.
  - 2. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
  - 3. Obtain, submit releases enabling Owner unrestricted use of the Work and access to services and utilities.
  - 4. Regulatory requirements:
    - a. Where required, obtain occupancy permits, operating certificates, similar releases.
    - b. Obtain necessary State, City, Fire, Building Department, Generator inspections as required
    - c. Generator and EC inspections will be allowed after beneficial occupancy and before final completion.
  - 5. Bonding and insurance:
    - a. Consent of Surety to Reduction In or Partial Release of Retainage.
    - b. Advise Owner of pending insurance change-over-requirements.
  
- C. Inspection Procedures:
  - 1. When prerequisites are complete, submit request in writing to Engineer stating that all requirements are satisfied, and requesting inspection.
  - 2. Upon receipt of Contractor's request for inspection, Engineer will either proceed with inspection or advise Contractor of unfilled prerequisites.
  - 3. Following initial inspection, Engineer will either prepare Certificate of Substantial Completion, or advise Contractor of work which must be performed before certificate will be issued. Engineer will repeat inspection when requested and when assured that work has been substantially completed.

4. Results of completed inspection will form the basis of requirements for Final Acceptance.

### 1.03 FINAL ACCEPTANCE & SUBSTANTIAL COMPLETION

- A. Completion Dates
  1. Deadline for substantial completion will be October 31, 2025.
  2. Failure to meet substantial completion requirements will result in liquidated damages.
- B. Before requesting final inspection for determining date of Substantial Completion, complete the following:
  1. Submittals:
    - a. Lien Waivers (from all subcontractors and suppliers).
    - b. Certificate of Substantial Completion (AIA G704) - 3 copies.
    - c. Contractor's Affidavit of Payment of Debts and Claims (AIA G706).
    - d. Contractor's Affidavit of Release of Liens (AIA G706A).
    - e. Consent of Surety (if Performance Bond provided).
      - 1) To Partial Release of Retainage (AIA G707A).
      - 2) To Final Payment (AIA G707).
    - f. Assurance that unsettled claims will be settled.
    - g. Proof that fees and similar obligations have been paid.
    - h. Evidence of final, continuing insurance coverage complying with insurance requirements.
    - i. Certified copy of Engineer's final punch list of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance and has been endorsed and dated by Engineer.
  2. Warranties: Submit specific warranties, workmanship/maintenance bonds, maintenance agreements, final certifications, similar documents on, but not limited to, the following items:
    - a. Pumps
    - b. Filters
    - c. Chemical Feed Equipment
    - d. Automated valves
    - e. Valves
    - f. Water quality monitoring equipment
    - g. HVAC Equipment
    - h. Electrical Equipment
    - i. Control Systems
  3. Maintenance:
    - a. Materials (each type and color):
      - 1) Masonry.
      - 2) Tile.
      - 3) Ceiling panels.
      - 4) Paint.
      - 5) Fuses.
    - b. Equipment
      - 1) Pumps
      - 2) Filters
      - 3) Chemical Feed Equipment
      - 4) Automated valves
      - 5) Valves
      - 6) Water quality monitoring equipment
      - 7) HVAC Equipment
      - 8) Electrical Equipment
      - 9) Control Systems
    - c. Maintenance instructions.
    - d. Maintenance services:
      - 1) Roof hatches.
    - e. Maintenance manuals: See Section 01 78 23
      - 1) Organize operating, maintenance data into suitable sets of manageable size.

- 2) Bind into individual heavy-duty 2-inch, 3-ring vinyl-covered binders with pocket folders, each set of data, marked with appropriate identification on both front and spine of each binder.
- 3) Include:
  - a) Emergency instructions.
  - b) Spare parts listing.
  - c) Copies of warranties.
  - d) Wiring diagrams.
  - e) Recommended "turnaround" cycles.
  - f) Inspection procedures.
  - g) Shop Drawings and Product Data.
- 4. Miscellaneous Record Submittals:
  - a. Refer to other sections of specifications for requirements of miscellaneous record keeping and submittals in connection with actual performance of work.
  - b. Complete miscellaneous records, place in good order, properly identified and bound or filed, ready for continued use and reference.
- 5. Records:
  - a. Test/adjust/balance records.
  - b. Startup performance reports.
  - c. Inspection Reports:
    - 1) All performed tests
- C. Record Drawings: Submit to Engineer a set of record prints marked to show "as-built" conditions for work of contract.
- D. Adjusting:
  - 1. Repair and restore marred exposed finishes.
  - 2. Touch up of painting of marred surfaces.
  - 3. Complete final cleaning requirements.
- E. Final Payment Request:
  - 1. Include certificates of insurance for products and completed operations where required.
  - 2. Updated final statement, accounting for final additional changes to Contract Sum.
  - 3. Final liquidated damages settlement statement, acceptable to Owner.
- F. Re-inspection Procedure:
  - 1. Engineer will re-inspect work upon receipt of notice that work, including punch list items resulting from earlier inspections, has been completed, except for items whose completion has been delayed because of circumstances that are acceptable to Engineer.
  - 2. Engineer will either prepare a certificate of final acceptance, or will advise Contractor of work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
  - 3. If necessary, re-inspection procedure will be repeated.

**1.04 TRANSFER OF SITE TO OWNER**

- A. Deliver tools, spare parts, extra materials and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
- B. Change door locks to Owner's access. Advise Owner's personnel of changeover in security provisions.
- C. Advise Owner of changeover in heat and other utilities.
- D. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

## **1.05 OPERATING AND MAINTENANCE INSTRUCTIONS/DEMONSTRATIONS**

- A. Arrange for each installer of operating equipment and other work requiring regular or continuing maintenance, to meet at Site with Owner's personnel to provide necessary basic instruction in proper operation and maintenance of entire work. Where installers are not experienced in required procedures, include instruction by manufacturer's representatives.
- B. Provide detailed review of following items:
  - 1. Maintenance manuals.
  - 2. Record documents.
  - 3. Spare parts and materials.
  - 4. Tools.
  - 5. Lubricants.
  - 6. Fuels.
  - 7. Identification systems.
  - 8. Control sequences.
  - 9. Hazards.
  - 10. Cleaning materials and procedures.
  - 11. Warranties, bonds, maintenance agreements similar continuing commitments.
- C. As part of this instruction for operating equipment, demonstrate following procedures:
  - 1. Start-up.
  - 2. Shut-down.
  - 3. Emergency operations.
  - 4. Noise and vibration adjustments.
  - 5. Safety procedures.
  - 6. Economy and efficiency adjustments.
  - 7. Effective energy utilization.
- D. Provide a video tape of above procedures.

## **PART 2 PRODUCTS**

### **2.01 CLEANING AGENTS**

- A. Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned.
- B. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## **PART 3 EXECUTION**

### **3.01 FINAL CLEANING**

- A. Provide final cleaning, following manufacturer's written instructions.
- B. Conduct cleaning and waste-removal operations to comply with local laws and ordinances, and federal and local environmental and antipollution regulations.
- C. Employ experienced workers or professional cleaners for final cleaning.
- D. Comply with safety standards for cleaning.
  - 1. Do not burn waste materials.
  - 2. Do not bury debris or excess materials on Owner's property.
  - 3. Do not discharge volatile, harmful, or dangerous materials into drainage systems.



4. Remove waste materials from Site and dispose of lawfully.
- E. Clean Site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
- F. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program.
  1. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
  2. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
  3. Remove tools, construction equipment, machinery, and surplus material from Site.
  4. Remove snow and ice to provide safe access to building.
  5. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
  6. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  7. Sweep concrete floors broom clean in unoccupied spaces.
  8. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
  9. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
  10. Remove labels that are not permanent.
  11. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  12. Replace parts subject to unusual operating conditions.
  13. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  14. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  15. Clean ducts, blowers, and coils if units were operated without filters during construction.
  16. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

**END OF SECTION**

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## SECTION 01 78 23

### OPERATION AND MAINTENANCE DATA

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes administrative and procedural requirements for operation and maintenance data:
  - 1. Submittals.
- B. Related Sections:
  - 1. Section 01 33 00 - Submittal Procedures
  - 2. Section 01 75 00 - Starting and Adjusting
  - 3. Section 01 77 00 - Closeout Procedures
  - 4. Individual Technical Sections

##### 1.02 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Form and Format:
  - 1. Organize operation, maintenance data for equipment prepared in the form of an instruction manual of manageable size.
  - 2. Bind into individual heavy-duty, 2-inch, 3-ring vinyl-covered binders with pocket folders, each set of data, marked with appropriate identification on both front and spine of each binder.
  - 3. Text shall be manufacturer's printed data or typewritten data on 20-pound paper; page size 8-1/2-inch by 11-inch. Computer generated data shall be by letter quality printers or laser printers.
  - 4. Clearly mark each sheet of product data to specify products, component parts, and data applicable to installation; delete inapplicable information.
  - 5. Drawings and photographs shall have reinforced, punched binder tabs. Bind in with text, folding larger drawings to size of text pages.
- C. Submittal Schedule:
  - 1. Submit one (1) digital copy of preliminary draft of contents no later than 45 calendar days after approval of Shop Drawings.
  - 2. Submit six (6) individually bound copies and one (1) digital copy of completed data in final form not later than 7 calendar days prior to first instruction of Owner personnel.
  - 3. If instruction of Owner personnel is not required, submit completed data no later than 14 calendar days prior to final inspection.
  - 4. Submit 6 copies of additional requested data no later than 21 calendar days following instruction of Owner personnel.

##### 1.03 QUALITY ASSURANCE

- A. Preparation of Project-specific data shall be by personnel trained and experienced in maintenance and operation of described products, equipment, systems, materials, or finishes.
- B. Photocopies: Drawings shall be legible and suitable for photocopying. All materials shall be reproducible. On material that contains data on several types/sizes/models of equipment, the specific type/size/model provided shall be clearly highlighted.

##### 1.04 CONTENTS

- A. Table of Contents: Include with each volume, with each product or system description identified.

- B. Directory:
1. List names, addresses and telephone numbers of:
    - a. Engineer.
    - b. Contractor.
    - c. Manufacturers and suppliers, including local source of supplies and replacement parts.
- C. Data to be Included:
1. Assembly, installation, alignment, inspection procedures.
  2. Critical tolerances.
  3. Startup procedures.
  4. Complete parts listing.
  5. Spare parts listing.
  6. Emergency instructions.
  7. Fabrication drawings.
  8. Copies of warranties.
  9. Recommended "turn-around" cycles.
  10. Inspection procedures.
  11. Shop Drawings and Product Data.
  12. Fixture lamping schedule.
- D. Data for Equipment and Systems:
1. Provide manufacturer's printed operation and maintenance instructions.
  2. Provide sequence of operation and as-installed control diagrams by controls manufacturer.
  3. Provide composite wiring diagrams for supervisory control systems. Include wiring diagrams showing connections between equipment wiring, electrical wiring, and supervisory control system wiring.
  4. For equipment, include description of unit and component parts. Give function, normal operation characteristics and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replacement parts.
  5. For panelboard circuit directories, indicate electrical service characteristics, controls, and communications. Include as-installed color coded wiring diagrams.
  6. Provide manufacturer's printed operation and maintenance instructions, including start-up, break-in, and normal operation instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operation instructions.
  7. For maintenance and preventative maintenance procedures include routine procedures; guide for "trouble-shooting;" and alignment, adjusting, balancing, and checking instructions.
  8. Provide servicing and lubrication schedule, and list of lubricants required.
  9. Provide manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance. Include recommended items and quantities to be stocked as spare parts.
- E. Data for Materials and Finishes:
1. For building products, applied materials, and finishes, include manufacturer's product data with catalog number, size, composition, and color and texture designations.
  2. List instructions for care, maintenance, and preventative maintenance; include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
  3. For moisture-protection and weather exposed products, include manufacturer's product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

## **PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

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## SECTION 01 78 37

### PRODUCT WARRANTIES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Requirements include administrative and procedural requirements for:
  - 1. Warranties
  - 2. Warranty submittals
- B. Related Sections:
  - 1. Section 01 33 00 - Submittal Procedures
  - 2. Section 01 77 00 - Closeout Procedures
  - 3. Individual Technical Sections

##### 1.02 DEFINITIONS

- A. Standard Product Warranties: Preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to Owner.
- B. Special Warranties: Written warranties required by, or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for Owner.

##### 1.03 WARRANTY REQUIREMENTS

- A. Separate Prime Contracts:
  - 1. Each prime Contractor is responsible for warranties related to its own contract. Each Contractor shall warrant their work for labor and material for 1-year minimum. This warranty shall include material purchased directly by Owner and installed by Contractor. Warranty requirements noted in individual sections may exceed this 1-year minimum; if it does, the warranty shall apply for the stipulated time for both material and labor.
- B. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- E. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of warranty on the Work that incorporates the products.
- F. Owner's Recourse: Written warranties made to Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which Owner can enforce such other duties, obligations, rights or remedies.
  - 1. Rejection of Warranties: Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

- G. Right of Refusal: Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

#### **1.04 SUBMITTALS**

- A. Warranty Commencement:
  - 1. Submit duplicate, notarized copies of written warranties to Engineer prior to the date certified for Substantial Completion. Engineer's Certificate of Substantial Completion shall be the commencement date for warranties.
  - 2. When a designated portion of the Work is completed and occupied or used by Owner, by separate agreement with Contractor during the construction period, submit properly executed warranties to Engineer within 15 days of completion of that designated portion of the Work.
  - 3. For items of Work delayed beyond the date of Substantial Completion, provide updated submittal within 10 days of acceptance by Owner, listing date of acceptance as start of warranty period.
- B. Special Warranty:
  - 1. When a special warranty is required to be executed by Contractor, or Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to Owner through Engineer for approval prior to final execution.
    - a. Execute and assemble documents from subcontractors, suppliers, and manufacturers.
    - b. Refer to individual sections of Divisions 2 through 46 for specific content requirements, and particular requirements for submittal of special warranties.
- C. Form of Submittal:
  - 1. At final completion compile 2 copies of each required warranty and bond properly executed by Contractor.
  - 2. Organize the warranty documents into an orderly sequence based on the Table of Contents of the Project Manual.
  - 3. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-inch by 11-inch paper.
    - a. Identify each binder on the front and the spine with the typed or printed title "Warranties and Bonds," the project title or name, and the name of Contractor.
    - b. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

Not Used

**END OF SECTION**



## SECTION 02 41 33

### REMOVING PAVEMENT AND MISCELLANEOUS STRUCTURES (WisDOT 204)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Removal and disposal of:
    - a. Pavements.
    - b. Underground pipe, manholes, and appurtenances.
    - c. Culverts.
    - d. Fencing and appurtenances
    - e. Abandoned structures.
    - f. Building demolition materials.
  - 2. Salvaging of designated materials.
  - 3. Backfilling of resulting depressions.
- B. Building Pre-Renovation Inspection Report for Well 19 is attached to this Section.
- C. Method of Measurement:
  - 1. No separate measurement, considered incidental to the lump sum project.
- D. Basis of Payment:
  - 1. No separate payment, considered incidental to the lump sum project.
  - 2.

##### 1.02 REFERENCES

- A. WisDOT 204 - Removing or Abandoning Miscellaneous Structures

#### PART 2 PRODUCTS

Not Used

#### PART 3 EXECUTION

##### 3.01 PREPARATION

- A. Sawing Pavement:
  - 1. Saw concrete pavement along removal lines through entire pavement thickness.
  - 2. Saw bituminous pavement along removal lines through entire pavement thickness.
  - 3. Produce a neat, square edge prior to restoration.
- B. Protect all in place structures and facilities not designated for removal.

##### 3.02 REMOVAL OPERATIONS

- A. Remove only structures and facilities that have been so marked by Engineer, including connected underground structures that are attached, such as footings for stoops.
- B. Complete all removal operations prior to adjacent new construction.
- C. Remove materials designated for salvage in a manner that will not result in damage.

- D. Completely remove structures that are designated for removal.
- E. Whenever possible, remove concrete to an existing joint.

### **3.03 DISPOSAL OF MATERIALS AND DEBRIS**

- A. Stockpile all materials designated for salvage at locations approved by Owner/Engineer.
- B. Dispose of all materials not designated for salvage in accordance with all applicable laws and ordinances.
- C. Disposal within the site will not be allowed.
- D. Burning operations will not be allowed.
- E. All surplus excavated materials shall become the property of Contractor for disposal.

### **3.04 BACKFILLING DEPRESSIONS**

- A. Backfill all depressions resulting from removals shall be in accordance with the Specifications.

**END OF SECTION**



**PRE-RENOVATION INSPECTION REPORT**

**Job Site:**

**Well 19 Gorder Station Building  
2526 Lake Mendota Drive  
Madison, Wisconsin**

**For:**

**City of Madison Water Utility  
Attn.: Dan Rodefeld  
110 South Paterson Street  
Madison, WI 53703**

**KPH Project # 23-400-125**

A handwritten signature in black ink, appearing to read "Dean Jacobsen", written over a horizontal line.

**Dean Jacobsen  
Asbestos Inspector No. AII – 14370**

**Prepared by:**

**KPH Environmental  
1237 West Bruce Street  
Milwaukee, Wisconsin 53204**

**June 2023**

<b>KPH ENVIRONMENTAL</b>	<b>WEB <a href="http://kphbuilds.com">kphbuilds.com</a></b>		
<b>WISCONSIN</b> ADDRESS 1237 West Bruce Street, Milwaukee, WI 53204	<b>PHONE 414.647.1530</b>	<b>FAX 414.647.1540</b>	
<b>MICHIGAN</b> ADDRESS 3737 Lake Eastbrook, Suite 203, Grand Rapids, MI 49503	<b>PHONE 616.920.0574</b>	<b>FAX 414.647.1540</b>	

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2526 Lake Mendota Drive  
Madison, Wisconsin

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## **EXECUTIVE SUMMARY**

KPH Environmental Corp (KPH), was retained by the City of Madison Water Utility to conduct an inspection of Well House 19 Gorder Station Building at 2526 Lake Mendota Drive, Madison, Wisconsin, prior to renovation. The locations inspected were those identified for renovation on the plan prepared by Short Elliott Hendrickson, Inc. (2/22/23). KPH conducted a visual inspection for asbestos and potential lead painted surfaces. KPH collected asbestos bulk samples and paint chip samples for laboratory analysis.

Locations inspected and sampled for asbestos included ceramic wall material at the toilet area and east employees only room, caulk and wall mastics in the east employees only room, exterior wall caulks, and roof materials. Asbestos was not detected in any of the materials sampled during this inspection. Asbestos results are in Section II of this report.

Suspect lead based paint was identified on the concrete floor of the east employees only room. Paint sample testing revealed that lead based paint was not detected here. Results are in Section III of this report.

## **I. INTRODUCTION**

KPH Environmental Corp., (KPH) was retained by the City of Madison Water Utility to conduct a pre-renovation inspection of the Well House 19 Gorder Station Building at 2526 Lake Mendota Drive, Madison, Wisconsin, for the following:

- Suspect asbestos containing materials at the planned renovation locations
- Suspect lead painted surfaces at the planned renovation locations

Dan Rodefled, of the City of Madison Water Utility, authorized KPH to conduct an inspection and to analyze samples collected during the inspection. The inspection of Well House 19 at 2526 Lake Mendota Drive, Madison, Wisconsin, was conducted on May 31, 2023, to cover the items listed above. The inspection was conducted by Dean Jacobsen, Wisconsin Asbestos Inspector License No. AII-14370 and Lead Risk Assessor License No. LRA-14370. Additional information on the inspection and results are contained in the following sections.

## **II. ASBESTOS INSPECTION**

### **A. Methods**

This asbestos inspection included a visual determination as to the extent of visible and accessible suspect materials at the selected locations in the building, sampling and documentation of any of these suspect materials, and quantification of observable and accessible positive materials existing within the spaces inspected.

An asbestos inspection involves inspecting all or part of a building (depending on the project scope) and identifying suspect asbestos containing materials. After suspect materials are identified, the

inspector divides the building into homogeneous areas. Homogeneous areas contain materials that are alike in color, composition, age of installation, and any other aspect. If any differences are identified during the inspection, a separate homogeneous area is established.

The inspector then collects bulk samples based upon the type of material and quantity of material in the homogeneous area. Bulk samples were placed into resealable containers and sent to a laboratory certified under the National Voluntary Laboratory Accreditation program (NVLAP) for analysis. Destructive sampling was not conducted where it would have adversely impacted suspect asbestos containing materials, to avoid building contamination.

The results of the survey integrated with the Polarized Light Microscopy with Dispersion Staining (PLM/DS) analysis of bulk samples taken are outlined in this document.

## **B. List of Suspect Asbestos Containing Materials**

The following types of suspect materials were observed and inspected to determine if asbestos containing materials were present in the buildings as required by US EPA NESHAP regulation 40 CFR 61 Subpart M, and NR 447 of the Wisconsin Administrative Code:

- Ceramic tile
- Caulk
- Roof tar flashing
- Mastics

A listing of specific homogeneous materials and homogeneous material codes are in the Samples and Results section following the results table.

## **C. The Laboratory**

Samples were analyzed at SanAir Laboratories Inc., for total asbestos content by volume using EPA Method 600/M4/82/020, 600/R-93/116. Analysis is performed by using the bulk samples for visual observation and slide preparation(s) for microscopical examination and identification. The slides are analyzed for asbestos (chrysotile, amosite, crocidolite, anthophyllite, and actinolite/ tremolite), fibrous non asbestos constituents (mineral wool, paper, etc.), and nonfibrous constituents. Asbestos is identified by refractive indices (obtained by using dispersion staining), morphology, color, pleochroism, birefringence, extinction characteristics, and signs of elongation. The same characteristics are used to identify the non asbestos constituents.

The microscopist visually estimates relative amounts of each constituent using a stereoscope if necessary. The test results are based on a visual determination of relative volume of the bulk sample components. The results are valid only for the item tested.

**Current regulations state asbestos containing materials (ACM) means material containing more than 1% asbestos as determined using the method specified in Appendix E, Subpart E, 40 CFR Part 763 Section I, Polarized Light Microscopy.** Bold values indicate that the material contains more than 1% asbestos. Negative results indicate that no asbestos was detected.

## D. Samples and Results

The following are the laboratory results. The laboratory report is in Appendix A. A floor plan with sample location is in Appendix C.

Sample #	Location and Description	Results	Homogeneous Code
1Aa	1 <sup>st</sup> floor – east toilet area – west wall near ceiling – tan ceramic tile	Negative	MCTMt
1Ab	1 <sup>st</sup> floor – east toilet area – west wall near ceiling – grout/mortar	Negative	MCTMt
1Ba	1 <sup>st</sup> floor – east employees only room – northwest wall near floor – tan ceramic tile	Negative	MCTMt
1Bb	1 <sup>st</sup> floor – east employees only room – northwest wall near floor – grout/mortar	Negative	MCTMt
1Ca	1 <sup>st</sup> floor – east employees only room – southwest wall near floor – tan ceramic tile	Negative	MCTMt
1Cb	1 <sup>st</sup> floor – east employees only room – southwest wall near floor – grout/mortar	Negative	MCTMt
2A	1 <sup>st</sup> floor – east employees only room – northwest corner wall – gray caulk	Negative	MCLKy
3Aa	1 <sup>st</sup> floor – east employees only room – on northwest wall – brown mastic	Negative	MWMn
3Ab	1 <sup>st</sup> floor – east employees only room – on northwest wall – gray paper	Negative	MWMn
4A	1 <sup>st</sup> floor – east employees only room – southeast wall under tan ceramic tile – older tan ceramic tile	Negative	MCTMt2
4Aa	1 <sup>st</sup> floor – east employees only room – southwest wall under tan ceramic tile – older tan ceramic tile	Negative	MCTMt2
4Ab	1 <sup>st</sup> floor – east employees only room – southwest wall under tan ceramic tile – older mortar	Negative	MCTMt2
5A	1 <sup>st</sup> floor – east employees only room – around southeast door – tan caulk	Negative	MCLKt
6A	Exterior – around northeast wall vent – tan caulk #2	Negative	MCLKt2
7A	Exterior – around southeast door – beige caulk	Negative	MCLKe
7B	Exterior – northeast wall – on seam near roof – beige caulk	Negative	MCLKe
8A	Exterior – northeast wall at PVC pipe – gray caulk #2	Negative	MCLKy2
9Aa	Roof – north side on roof deck seam – gray caulk #3	Negative	MCLKy3
9Ab	Roof – north side on roof deck seam – gray flashing	Negative	MRFy
9Ac	Roof – north side on roof deck seam – black tar	Negative	MTar
9Ba	Roof – center on roof deck seam – gray caulk #3	Negative	MCLKy3
9Bb	Roof – center on roof deck seam – gray flashing	Negative	MRFy
9Bc	Roof – center on roof deck seam – black tar	Negative	MTar
9Ca	Roof – south side on roof deck seam – gray caulk #3	Negative	MCLKy3
9Cb	Roof – south side on roof deck seam – gray flashing	Negative	MRFy
9Cc	Roof – south side on roof deck seam – black tar	Negative	MTar
10A	Roof – north side on metal strip seams – light gray caulk	Negative	MCLKy4
11A	Roof – north side on top of metal strip – clear caulk	Negative	MCLKcl

### Homogeneous Material Codes

MCTMt	Tan Ceramic Tile
MCTMt2	Older Tan Ceramic Tile
MCLKy	Gray Caulk Wall Corner

### Homogeneous Material Codes

MCLKy2	Gray Caulk at PVC Pipe
MCLKy3	Gray Caulk Roof Deck
MCLKy4	Light Gray Caulk Metal Strip
MCLKt	Tan Caulk Interior Door
MCLKt2	Tan Caulk Exterior Seam
MCLKcl	Clear Caulk
MWMn	Brown Wall Mastic
MRFy	Gray Flashing
Mtar	Roof Tar

### E. Asbestos Locations and Quantities

None of the materials sampled contains asbestos.

**Note#1:** If additional materials are discovered during the renovation that are not listed above they are to be assumed to be asbestos containing.

**Note#2:** A copy of this report should be transmitted to the renovation contractor.

## III. LEAD PAINT INSPECTION

### A. Methods

A lead paint inspection and sampling are recommended for building materials that may contain surfaces painted before 1978. The inspection determines if lead is in the building paint, the location(s) of lead containing surfaces, and the amount of lead in the paint. If the surfaces will be disturbed or demolished, workers can then prepare proper safety measures to reduce exposure to lead containing dust as required by the Occupational Safety and Health Administration. In addition, the Wisconsin Department of Natural Resources requires determination of lead based paint prior to disposal or recycling of building materials (Concrete Recycling and Disposal Fact Sheet WA-605 2017).

The lead paint inspection of the Well House 19 Gorder Station Building at 2526 Lake Mendota Drive, Madison, Wisconsin, took place on May 31, 2023. A room by room inspection was conducted of locations scheduled for renovation, noting the location, substrate, and color of these surfaces where painted.

### B. Component Testing Results

The Wisconsin State Statutes Chapter 254.11(8) defines lead-based paint as having a surface concentration of lead that is more than 0.5% of lead per weight of a dried paint sample.

**The results of the analysis was classified as follows:**

**Positive:** Any result above the Chapter 254 Standard of 0.5% lead.

**Negative:** Any result at or below the Chapter 254 Standard of 0.5% lead.



**Interior:** Painted concrete floor was observed in the east employees only room. Lead based paint was not detected.

**Exterior:** No painted surfaces were observed on the exterior.

The following are the laboratory results.

Paint Testing Results					
Sample	Room	Component	Substrate	Color	Result (% Lead)
1P	East Employees Only Room	Northwest Floor	Concrete	Gray	<0.009

See the OSHA Lead in Construction booklet (OSHA 3142-09R 2003) for guidance and <https://www.osha.gov/SLTC/lead/index.html> for regulatory requirements.

#### IV. EXCLUSIONS

This report represents the condition of the building and the visible/accessible materials inspected at the date and the times of the onsite inspection. Areas and materials that were hidden or not accessible are excluded, including areas within walls and floors. Hidden materials or those materials that could not be accessed at the point of inspection, over and above those stated in the inspection report, are the responsibility of the building owner and the renovation contractor.

A limited lead inspection was conducted. The results are representative only of the specific locations that were inspected on the building. This report represents the condition of the buildings and the visible/accessible locations at the date and the time of the onsite inspection.

#### VI. LIMITATIONS

The care and skill given to our procedures insures the most reliable test results possible. The findings and conclusions of KPH represent our professional opinions extrapolated from limited data. Significant limited data is gathered during the course of the building inspection. No other warranty is expressed or implied. Prior to any renovation activities, it is recommended that KPH be provided the opportunity to review such plans in order that the inspection and assessments contained herein are properly interpreted and implemented.

*This report and the information contained herein are prepared for the sole and exclusive use and possession of the City of Madison Water Utility. No other person or entity may rely on this report or any information contained herein. Any dissemination of the Report or any information contained herein is strictly prohibited without prior written authorization from KPH Environmental Corp*

## APPENDICES

## **A. ASBESTOS LABORATORY RESULTS**



SanAir ID Number  
**23029969**  
FINAL REPORT  
6/14/2023 12:55:44 PM

**Name:** KPH Environmental Corp.  
**Address:** 1237 West Bruce Steet  
Milwaukee, WI 53204  
**Phone:** 414-647-1530

**Project Number:** 23-400-125  
**P.O. Number:**  
**Project Name:** Well House 19  
**Collected Date:** 5/31/2023  
**Received Date:** 6/1/2023 10:40:00 AM

Dear Dean Jacobsen,

We at SanAir would like to thank you for the work you recently submitted. The 17 sample(s) were received on Thursday, June 01, 2023 via UPS. The final report(s) is enclosed for the following sample(s): 1A, 1B, 1C, 2A, 3A, 4A, 4B, 5A, 6A, 7A, 7B, 8A, 9A, 9B, 9C, 10A, 11A.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

A handwritten signature in black ink that reads "Sandra Sobrino". The signature is written in a cursive, flowing style.

Sandra Sobrino  
Asbestos & Materials Laboratory Manager  
SanAir Technologies Laboratory

Final Report Includes:

- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:

- 17 samples in Good condition.



SanAir ID Number  
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 6/14/2023 12:55:44 PM

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**Received Date:** 6/1/2023 10:40:00 AM

Analyst: Hogrefe, Sarah

### Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic		Components		Asbestos Fibers
	Appearance	% Fibrous	% Non-fibrous		
1A / 23029969-001 , Tile	Beige Non-Fibrous Homogeneous		100% Other		None Detected
1A / 23029969-001 , Mortar	Grey Non-Fibrous Heterogeneous		100% Other		None Detected
1B / 23029969-002 , Tile	Beige Non-Fibrous Homogeneous		100% Other		None Detected
1B / 23029969-002 , Mortar	Grey Non-Fibrous Heterogeneous		100% Other		None Detected
1C / 23029969-003 , Tile	Beige Non-Fibrous Homogeneous		100% Other		None Detected
1C / 23029969-003 , Mortar	Grey Non-Fibrous Heterogeneous		100% Other		None Detected
2A / 23029969-004	Grey Non-Fibrous Homogeneous		100% Other		None Detected
3A / 23029969-005 , Mastic	Brown Non-Fibrous Homogeneous		100% Other		None Detected
3A / 23029969-005 , Paper	Grey Fibrous Homogeneous	99% Cellulose	1% Other		None Detected
4A / 23029969-006	Tan Non-Fibrous Homogeneous		100% Other		None Detected

Analyst:

Approved Signatory:

Analysis Date: 6/14/2023

Date: 6/14/2023



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**Received Date:** 6/1/2023 10:40:00 AM

Analyst: Hogrefe, Sarah

### Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Components			Asbestos Fibers
	Appearance	% Fibrous	% Non-fibrous	
4B / 23029969-007 , Tile	Tan Non-Fibrous Homogeneous		100% Other	None Detected
4B / 23029969-007 , Mortar	Grey Non-Fibrous Heterogeneous		100% Other	None Detected
5A / 23029969-008	Tan Non-Fibrous Homogeneous		100% Other	None Detected
6A / 23029969-009	Tan Non-Fibrous Homogeneous		100% Other	None Detected
7A / 23029969-010	Tan Non-Fibrous Homogeneous		100% Other	None Detected
7B / 23029969-011	Tan Non-Fibrous Homogeneous		100% Other	None Detected
8A / 23029969-012	Grey Non-Fibrous Homogeneous		100% Other	None Detected
9A / 23029969-013 , Caulk	Grey Non-Fibrous Homogeneous		100% Other	None Detected
9A / 23029969-013 , Coating	Grey Non-Fibrous Homogeneous		100% Other	None Detected
9A / 23029969-013 , Tar	Black Non-Fibrous Homogeneous	10% Cellulose	90% Other	None Detected

Analyst:

Approved Signatory:

Analysis Date: 6/14/2023

Date: 6/14/2023



SanAir ID Number  
**23029969**  
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**Received Date:** 6/1/2023 10:40:00 AM

Analyst: Hogrefe, Sarah

### Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Components			Asbestos Fibers
	Appearance	% Fibrous	% Non-fibrous	
9B / 23029969-014 , Caulk	Grey Non-Fibrous Homogeneous		100% Other	None Detected
9B / 23029969-014 , Coating	Grey Non-Fibrous Homogeneous		100% Other	None Detected
9B / 23029969-014 , Tar	Black Non-Fibrous Homogeneous	10% Cellulose	90% Other	None Detected
9C / 23029969-015 , Caulk	Grey Non-Fibrous Homogeneous		100% Other	None Detected
9C / 23029969-015 , Coating	Grey Non-Fibrous Homogeneous		100% Other	None Detected
9C / 23029969-015 , Tar	Black Non-Fibrous Homogeneous	10% Cellulose	90% Other	None Detected
10A / 23029969-016	Grey Non-Fibrous Homogeneous		100% Other	None Detected
11A / 23029969-017	Clear Non-Fibrous Homogeneous		100% Other	None Detected

Analyst:

Approved Signatory:

Analysis Date: 6/14/2023

Date: 6/14/2023

## Disclaimer

This report is the sole property of the client named on the SanAir Technologies Laboratory chain-of-custody (COC). Results in the report are confidential information intended only for the use by the customer listed on the COC. Neither results nor reports will be discussed with or released to any third party without our client's written permission. The final report shall not be reproduced except in full without written approval of the laboratory to assure that parts of the report are not taken out of context. The information provided in this report applies only to the samples submitted and is relevant only for the date, time, and location of sampling. The accuracy of the results is dependent upon the client's sampling procedure and information provided to the laboratory by the client. SanAir assumes no responsibility for the sampling procedure and will provide evaluation reports based solely on the sample(s) in the condition in which they arrived at the laboratory and information provided by the client on the COC, such as: project number, project name, collection dates, po number, special instructions, samples collected by, sample numbers, sample identifications, sample type, selected analysis type, flow rate, total volume or area, and start stop times that may affect the validity of the results in this report. Samples were received in good condition unless otherwise noted on the report. SanAir assumes no responsibility or liability for the manner in which the results are used or interpreted. This report does not constitute and shall not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any other U.S. governmental agencies and may not be certified by every local, state, and federal regulatory agencies.

Samples are held for a period of 60 days. Fibers smaller than 5 microns cannot be seen with this method due to scope limitations.

For NY state samples, method EPA 600/M4-82-020 is performed.

### NYELAP Disclaimer:

Polarized- light microscopy is not consistently reliable in detecting asbestos in floor covering and similar non-friable organically bound materials. Quantitative transmission electron microscopy is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos containing.

### Asbestos Certifications

NVLAP lab code 200870-0

City of Philadelphia: ALL-460

PA Department of Environmental Protection Number: 68-05397

California License Number: 2915

Colorado License Number: AL-23143

Connecticut License Number: PH-0105

Massachusetts License Number: AA000222

Maine License Number: LB-0075, LA-0084

New York ELAP lab ID: 11983

Rhode Island License Number: PCM00126, PLM00126, TEM00126

Texas Department of State Health Services License Number: 300440

Commonwealth of Virginia 3333000323

Washington State License Number: C989

West Virginia License Number: LT000616

Vermont License: AL166318

Louisiana Department of Environmental Quality: 212253, Cert 05088

Revision Date: 8/14/2020





10501 Trade Ct., Suite 100  
 N. Chesterfield, VA 23236  
 804.897.1177 / 888.895.1177  
 Fax 804.897.0070  
[sanair.com](http://sanair.com)

**Asbestos**  
**Chain of Custody**  
 Form 140, Rev 7, 10/20/2022

SanAir ID Number  
 23029969

Company: <b>KPH Environmental Corp.</b>	Project #: <b>23-400-125</b>	Collected by:
Address: <b>1237 West Bruce Street</b>	Project Name: <b>Well House 19</b>	Phone #: <b>(414) 647-1530</b>
City, St., Zip: <b>Milwaukee, WI 53204</b>	Date Collected: <b>5/31/23</b>	Fax #: <b>(414) 647-1540</b>
State of Collection: <b>WI</b> Account#: <b>3905</b>	P.O. Number:	Email: <b>dean.jacobsen@kphenvironmental.com</b>

Bulk			Air			Soil		
ABB	PLM EPA 600/R-93/116	<input checked="" type="checkbox"/>	ABA	PCM NIOSH 7400	<input type="checkbox"/>	ABSE	PLM EPA 600/R-93/116 (Qual.)	<input type="checkbox"/>
	Positive Stop	<input type="checkbox"/>	ABA-2	OSHA w/ TWA*	<input type="checkbox"/>	<b>Vermiculite</b>		
ABEPA	PLM EPA 400 Point Count	<input type="checkbox"/>	ABTEM	TEM AHERA	<input type="checkbox"/>	ABB	PLM EPA 600/R-93/116	<input type="checkbox"/>
ABB1K	PLM EPA 1000 Point Count	<input type="checkbox"/>	ABATN	TEM NIOSH 7402	<input type="checkbox"/>	ABEPA3	PLM EPA 400 Point Count	<input type="checkbox"/>
ABBEN	PLM EPA NOB**	<input type="checkbox"/>	ABT2	TEM Level II	<input type="checkbox"/>	ABCM	Cincinnati Method	<input type="checkbox"/>
ABBCH	TEM Chatfield**	<input type="checkbox"/>	Other:		<input type="checkbox"/>	<b>Dust</b>		
ABBTM	TEM EPA NOB**	<input type="checkbox"/>	<b>New York ELAP</b>			ABWA	TEM Wipe ASTM D-6480	<input type="checkbox"/>
ABQ	PLM Qualitative	<input type="checkbox"/>	ABEPA2	NY ELAP 198.1	<input type="checkbox"/>	ABDMV	TEM Microvac ASTM D-5755	<input type="checkbox"/>
** Available on 24-hr. to 5-day TAT			ABENY	NY ELAP 198.6 PLM NOB	<input type="checkbox"/>	<b>Matrix Other</b>		
<b>Water</b>			ABBNY	NY ELAP 198.4 TEM NOB	<input type="checkbox"/>			<input type="checkbox"/>
ABHE	EPA 100.2	<input type="checkbox"/>		Positive Stop	<input type="checkbox"/>			<input type="checkbox"/>

Turn Around Times	3 HR (4 HR TEM) <input type="checkbox"/>	6 HR (8HR TEM) <input type="checkbox"/>	12 HR <input type="checkbox"/>	1 Day <input type="checkbox"/>
	<input type="checkbox"/> 2 Days	<input type="checkbox"/> 3 Days	<input type="checkbox"/> 4 Days	<input checked="" type="checkbox"/> 5 Days

**Special Instructions**

Sample #	Sample Identification/Location	Volume or Area	Sample Date	Flow Rate*	Start - Stop Time*
1A					
1B					
1C					
2A					
3A					
4A					
4B					
5A					
6A					
7A					
7B					
8A					

Relinquished by <i>[Signature]</i>	Date <b>5/31/23</b>	Time <b>1:50</b>	Received by <i>[Signature]</i>	Date <b>6-1-23</b>	Time <b>10:40 AM</b>
---------------------------------------	------------------------	---------------------	-----------------------------------	-----------------------	-------------------------

2302 9969

Form 140, Revision 1, 1/20/2017

Sample #	Sample Identification/Location	Volume or Area	Sample Date	Flow Rate*	Start - Stop Time*
9A					
9B					
9C					
10A					
11A					

**Special Instructions**

Relinquished by	Date	Time	Received by	Date	Time
	5/3/23	1700	ESC	6-1-23	10:40 AM

If no technician is provided, then the primary contact for your account will be selected. Unless scheduled, the turnaround time for all samples received after 3 pm EST will be logged in the next business day. Weekend or holiday work must be scheduled ahead of time and is charged at 150% of the 3hr TAT or a minimum charge of \$150. A courier charge will be applied for same day and one-day turnaround times for offsite work. SanAir covers Ground and Next Day Air shipping. Shipments billed to SanAir with a faster shipping rate will result in additional charges. Page 2 of 2

## **B. PAINT LABORATORY RESULTS**



SanAir ID Number  
**23029974**  
FINAL REPORT  
6/8/2023 11:44:52 AM

**Name:** KPH Environmental Corp.  
**Address:** 1237 West Bruce Steet  
Milwaukee, WI 53204  
**Phone:** 414-647-1530

**Project Number:** 23-400-125  
**P.O. Number:**  
**Project Name:** Well House 19  
**Collected Date:** 5/31/2023  
**Received Date:** 6/1/2023 10:40:00 AM

Dear Dean Jacobsen,

We at SanAir would like to thank you for the work you recently submitted. The 1 sample(s) were received on Thursday, June 01, 2023 via UPS. The final report(s) is enclosed for the following sample(s): 1P.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

A handwritten signature in black ink that reads "Abisola Kasali". The signature is written in a cursive style.

Abisola Kasali  
Metals Laboratory Director  
SanAir Technologies Laboratory

Final Report Includes:  
- Cover Letter  
- Analysis on Test Family AA  
- Disclaimers and Additional Information

Sample conditions:  
- 1 samples in Good condition.



SanAir ID Number  
**23029974**  
 FINAL REPORT  
 6/8/2023 11:44:52 AM

**Name:** KPH Environmental Corp.  
**Address:** 1237 West Bruce Steet  
 Milwaukee, WI 53204  
**Phone:** 414-647-1530

**Project Number:** 23-400-125  
**P.O. Number:**  
**Project Name:** Well House 19  
**Collected Date:** 5/31/2023  
**Received Date:** 6/1/2023 10:40:00 AM

Analyst: Rivera, Shirley  
 Test Method: SW846/M3050B/7000B

### Lead Paint Analysis

PAINT Sample	Description	µg Pb In Sample	Sample Size (grams)	Calculated RL	Sample Results	Sample Results
23029974 - 1	1P	< 10	0.108	92.6	<92.6 µg/g (ppm)	<0.009 % By Weight

Method Reporting Limit <10 µg/0.1 g paint

Signature: *Shirley Rivera*  
 Date: 6/2/2023

Reviewed: *Abisela*  
 Date: 6/5/2023

## Disclaimer

SanAir Technologies Laboratory, Inc. participates in the Environmental Lead Accreditation Program (ELAP) administered by AIHA-LAP, LLC (Lab ID162952). Refer to our accreditation certificate or [www.aihaaccreditedlabs.org](http://www.aihaaccreditedlabs.org) for an up to date list of the Fields of Testing for which we are accredited. SanAir also participates in the State of New York's DOH-ELAP (Lab Id 11983), and has met the EPA's NLLAP program standards. This report does not constitute endorsement by AIHA-LAP, LLC and/or any other U.S. governmental agencies; and may not be accredited by every local, state or federal regulatory agency.

This report is the sole property of the client named on the SanAir Technologies Laboratory chain-of-custody (COC). Neither results nor reports will be discussed with or released to any third party without our client's written permission. Final reports cannot be reproduced, except in full, without written authorization from SanAir Technologies Laboratory, Inc. The information provided in this report applies only to the samples submitted and is relevant only for the date, time, and location of sampling. SanAir is not responsible for sample collection or interpretation made by others. SanAir assumes no responsibility for information provided by the client on the COC such as project number, project name, collection dates, po number, special instructions, samples collected by, sample numbers, sample identifications, sample type, selected analysis type, flow rate, total volume or area, and start stop times that may affect the validity of the results in this report. SanAir Technologies Laboratory, Inc only assures the precision and accuracy of the data it generates and assumes no responsibility for errors or biasing that occur during collection prior to SanAir's receipt of the sample(s). SanAir's Method Detection Limits (MDL) and Reporting Limits (RL) have been derived using various materials meeting each accrediting agencies' standards. All quality control results are acceptable unless otherwise noted. Results are not corrected for blanks. For Lead Exposure Limits in Paint, refer to HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards and State and Federal Regulations, where applicable.



10501 Trade Ct.  
 N. Chesterfield, VA 23236-3993  
 804.897.1177 / 888.895.1177  
 Fax 804.897.0070  
 sanair.com

**Metals & Lead  
 Chain of Custody**  
 Form 70, Revision 11, 09/21/21

SanAir ID Number  
 23029974

Company: <b>KPH Environmental Corp.</b>	Project #: <b>23-400-125</b>	Phone #: <b>(414) 647-1530</b>
Address: <b>1237 West Bruce Street</b>	Project Name: <b>Well House 19</b>	Phone #:
City, St., Zip: <b>Milwaukee, WI 53204</b>	Date Collected: <b>5/31/23</b>	Fax #: <b>(414) 647-1540</b>
Samples Collected By:	P.O. Number:	Email: <b>dean.jacobsen@kphenvironmental.com</b>
Account #: <b>3905</b>	U.S. State Collected in: <b>WI</b>	Email:

**Matrix Types**

**Metals Analysis Types**

<input type="checkbox"/> Air (ug/m <sup>3</sup> )	Total Concentration of Lead <input checked="" type="checkbox"/>	<input type="checkbox"/> ICP-total concentration of metals (please list metals):		
<input type="checkbox"/> Wipe (ug/ft <sup>2</sup> )	Total Concentration of RCRA 8 Metals <input type="checkbox"/>			
<input checked="" type="checkbox"/> Paint <input type="checkbox"/> Soil <input type="checkbox"/> Bulk (ug/g or ppm)	TCLP for Lead <input type="checkbox"/>			
<input type="checkbox"/> Other:	TCLP for RCRA 8 Metals <input type="checkbox"/>			
<b>Turn Around Time</b>	Same Day <input type="checkbox"/>	1 Day <input type="checkbox"/>	2 days <input type="checkbox"/>	3 Days <input type="checkbox"/>
	<input type="checkbox"/> 4 Days	<input checked="" type="checkbox"/> Standard (5 day)	<input type="checkbox"/> Other Test:	

Sample #	Collection Date & Time	Sample Identification/Location	Flow Rate	Start Time	Stop Time	Volume (L) Area (Sq ft)
1P	5/31/23					

**Special Instructions**

Relinquished by	Date	Time	Received by	Date	Time
<i>[Signature]</i>	5/31/23	12:00	<i>[Signature]</i>	6-1-23	10:40 AM

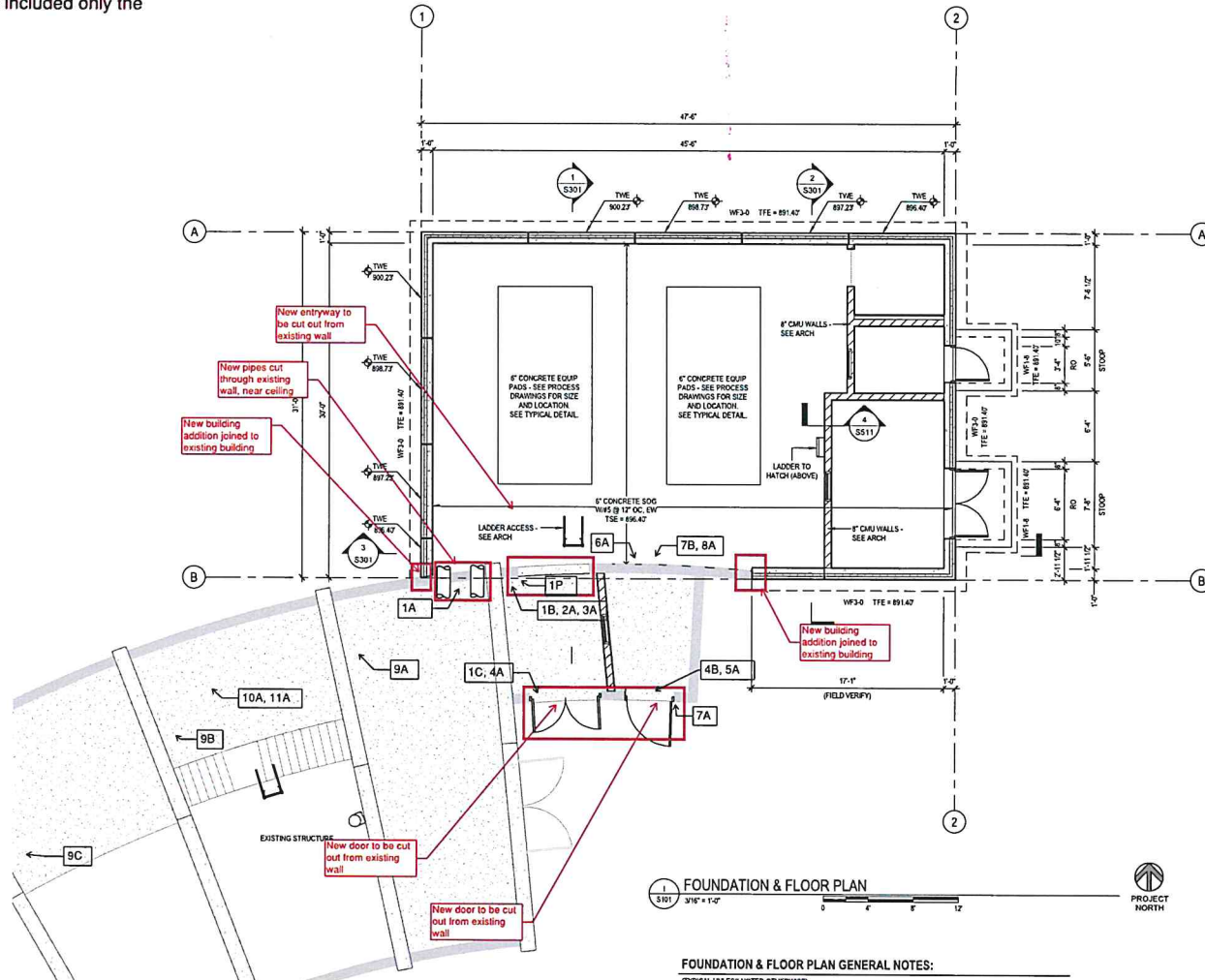
If no technician is provided, then the primary contact for your account will be selected. Unless scheduled, the turnaround time for all samples received after 3 pm EST will be logged in the next business day. Weekend or holiday work must be scheduled ahead of time and is charged at 150% of the 3hr TAT or a minimum charge of \$150. A courier charge will be applied for same day and one-day turnaround times for offsite work. SanAir covers Ground and Next Day Air shipping. Shipments billed to SanAir with a faster shipping rate will result in additional charges.

## **C. SAMPLE LOCATIONS**



Locations inspected for the presence of asbestos materials or lead painted surfaces included only the location marked in red below.

← 1A Sample Location N



1 FOUNDATION & FLOOR PLAN  
 3/16" = 1'-0"  
 PROJECT NORTH

**FOUNDATION & FLOOR PLAN GENERAL NOTES:**

- (TYPICAL UNLESS NOTED OTHERWISE)
1. VERIFY ALL DIMENSIONS AND CONDITIONS WITH ARCHITECTURAL DRAWINGS.
  2. VERIFY ALL SIZES, LOCATIONS, AND ELEVATIONS OF OPENINGS WITH MECH, ELEC. & PROCESS DRAWINGS. REINFORCE AS NECESSARY PER TYP DETAILS ON S501 & S511.
  3. VERIFY ALL SIZES AND LOCATIONS OF STOOPS, APRONS, AND OTHER WALL OPENINGS WITH ARCHITECTURAL DRAWINGS.
  4. SEE ARCH AND CIVIL DRAWINGS FOR REFERENCE DATUM.

NOT FOR CONSTRUCTION

CITY OF MADISON WATER UTILITY  
 UNIT WELL 19 TREATMENT SYSTEM ADDITION  
 WELLHOUSE 19  
 2526 LAKE MENDOTA DRIVE  
 MADISON, WISCONSIN

Project Status: N/A Drawings: Issue D: 3/2/2021

REV. #	DESCRIPTION	DATE

FOUNDATION & FLOOR PLAN

01  
 S101

## **D. KPH CERTIFICATION**

# Company Certificate

This certifies that

**KPH ENVIRONMENTAL CORPORATION**

1237 W BRUCE ST  
MILWAUKEE WI 53204-1218

is certified under ch. DHS 159, Wis. Adm. Code as a

**Asbestos Company -- Primary**

Certificate Issue Date: 08/01/2022

Expiration Date: 09/10/2024, 12:01 a.m.

Certification #: CAP-1432180

Wisconsin Department of Health Services  
Division of Public Health  
Bureau of Environmental and Occupational Health  
Asbestos & Lead Section  
PO Box 2659  
Madison WI 53701-2659  
Phone: (608) 261-6876



*Miriam Hasan*

Miriam Hasan, Unit Supervisor



ASBESTOS INSPECTOR

Issued By

STATE OF WISCONSIN  
Dept. of Health Services

Dean T Jacobsen  
W131 S6781 Kipling Dr  
Muskego WI 53150-3401

		160 lbs	5' 08"
AII-14370	Exp: 05/29/2024	12/12/1963	

Training due by: 05/29/2024

Tony Evers  
Governor



DIVISION OF PUBLIC HEALTH  
SOUTHERN REGIONAL OFFICE  
1 WEST WILSON STREET ROOM 250  
MADISON WI 53703-3445

Karen E. Timberlake  
Secretary

State of Wisconsin  
Department of Health Services

Fax: 608-267-2832  
TTY: 711 or 800-947-3529

**Congratulations! Your new certification card is enclosed.** ¡Felicidades! Se incluye su nueva tarjeta de certificación.

**Keep your card (or a copy of it) with you on job sites. This may be a digital copy, like a photo on your phone.**



Mantenga su tarjeta (o una copia de ésta) con usted en los lugares de trabajo. Ésta puede ser una copia digital, como una foto en su teléfono.

**Work safely using the methods you learned in class.**



Trabaje de manera segura utilizando los métodos que aprendió en clase.

**Work for a certified company. Both company and individual certification are required.**



Trabaje para una empresa certificada. Se requiere tanto la certificación de la empresa como la individual.

**Don't do regulated work after your card expires.**



No haga trabajos regulados después de que su tarjeta caduque.

**Contact us with questions.** Contacte con nosotros si tiene preguntas.

Lead and Asbestos Certification Program  
DHSAbestosLead@wi.gov  
www.dhs.wi.gov/asbestos  
www.dhs.wi.gov/lead  
(608) 261-6876

**We recommend taking a clear photo of your card and keeping it stored on your phone as back-up proof of on-site certification.**



LEAD(PB) RISK ASSESSOR

Issued By

STATE OF WISCONSIN

Dept. of Health Services

Dean T Jacobsen  
W131 S6781 Kipling Dr  
Muskego WI 53150-3401

Le recomendamos que tome una foto clara de su tarjeta y la guarde en su teléfono como prueba de respaldo de la certificación en el sitio.

		160 lbs	5' 08"
LRA-14370	Exp: 11/19/2024	12/12/1963	

Training due by: 11/19/2024

**SECTION 03 11 00**  
**CONCRETE FORMING**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Design and installation of formwork with shoring, bracing and anchorage for cast-in-place concrete.

**1.02 REFERENCES**

- A. ACI 347 - Recommended Practice for Concrete Formwork

**1.03 SUBMITTALS**

- A. Submit Product Data for form ties.

**1.04 QUALITY ASSURANCE**

- A. The design, engineering, and proper construction of all formwork shall be the responsibility of the Contractor.
- B. Design formwork in accordance with ACI 347.

**1.05 PRODUCT HANDLING**

- A. Do not store forms or equipment on finished slabs.

**PART 2 PRODUCTS**

**2.01 FORM MATERIAL**

- A. Form Facing Material: Smooth faced, undamaged plywood or other panel type material approved by Engineer.
- B. The form facing material shall produce a smooth, hard, uniform texture on the concrete.
- C. The arrangement of the facing material shall be orderly and symmetrical with the number of seams kept to a minimum.
- D. Do not use facing material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface.
- E. Fiber Tube Forms: Continuous laminated fiber tube with exterior moisture protection and non-adhering interior surface similar to "A-Coated Sonotube" as manufactured by Sonoco Products, or approved equal.
- F. Void Forms:
  - 1. Corrugated fiberboard forms impregnated with paraffin, as manufactured by firm regularly engaged in production of corrugated fiberboard forms.
  - 2. Design to safely support dead load of concrete and construction live loads for period of 2 weeks.
  - 3. Design to prevent leakage of concrete or backfill materials and treat to prevent loss of strength and softening of form material due to moisture absorption.
  - 4. Size as shown on Drawings.

## **2.02 FORM TIES**

- A. Form Ties: Factory fabricated, adjustable length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling concrete surfaces upon removal.
- B. The portion of the tie remaining in the concrete after removal of the tie shall be at least 1 inch from the surface of the concrete.
- C. Provide waterseals on all wall ties used in water containment structures and exterior walls.

## **2.03 FORM COATINGS**

- A. Form Coatings or Release Agents: Commercially formulated chemical release agents containing no lubrication oil, conventional form oil, fuel oil, or kerosene. Containers shall have manufacturer's instructions for use printed thereon.
- B. The form coating shall not penetrate, stain, or leave a residual film on the concrete surface and shall not attract dirt or other deleterious material.

## **2.04 ACCESSORIES**

- A. Chamfer Strips: 3/4-inch by 3/4-inch wood or plastic strips.
- B. Provide all anchorages, braces, and special forms required to construct cast-in-place concrete components shown on the Drawings.

## **PART 3 EXECUTION**

### **3.01 FIELD QUALITY CONTROL**

- A. Comply with requirements of Section 01 45 10 for testing and inspection frequency and responsibilities.
- B. Inspect formwork for shape, location and dimensions of the concrete member being formed for conformance with the plans, approved shop drawings, and tolerances given in this section.

### **3.02 GENERAL**

- A. Establish a benchmark in an accessible location and use as a reference point for various construction levels.
- B. Verify lines, levels, and centers before proceeding with formwork.
- C. Ensure that dimensions agree with the Drawings. Report any discrepancies to Engineer before proceeding with Work.

### **3.03 FORMWORK DESIGN**

- A. The design and construction of the formwork shall be the responsibility of the Contractor.
- B. Design formwork in accordance with ACI 347.
- C. Formwork shall be designed, erected, supported, braced, and maintained to safely support all vertical and lateral loads that might be applied until such loads can be supported by the concrete structure.
- D. Camber formwork to compensate for anticipated deflections in the formwork prior to hardening of the concrete.

- E. Provide positive means of adjustment of shores and struts.
  - 1. Take up all settlement during concrete placing operations.
  - 2. Securely brace forms against lateral deflections.

### 3.04 FORMWORK CONSTRUCTION

- A. Provide forms for all concrete work. Do not use earth cuts as forms for vertical surfaces.
- B. Construct forms to conform to slopes, lines, and dimensions shown on the Drawings.
- C. Forms shall be sufficiently tight to prevent loss of mortar from the concrete.
- D. Place chamfer strips at all exposed corners.
- E. Install all required openings, frames, pipe sleeves, cavities, slots, and other embedded items.
- F. Cut all holes in forms required for installation or embedment of concrete reinforcement bars and ties.
- G. Provide sharp clean corners at intersecting planes without visible edges or offsets. Back joints with extra studs or girts to maintain true, square corners.
- H. Provide temporary openings at the base of column forms and wall forms to facilitate cleaning and observation immediately before concrete is placed.
  - 1. Construct closures to ensure a tight fit flush with the adjoining surfaces.
- I. Provide runways for moving equipment.
  - 1. Provide runways with struts or legs and support directly on the formwork.
  - 2. Runways shall not rest on the reinforcing steel.
- J. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris before concrete is placed.
- K. Install Void Forms:
  - 1. Protect from moisture before concrete placement. Store above ground level in dry location.
  - 2. Do not use forms subjected to water, moist soils, or damp storage unless test loaded.
  - 3. Install on surface providing uniform support. Conform to recommendations of manufacturer.
  - 4. Protect from crushing and penetration of form at reinforcing steel supports and at other supports.

### 3.05 TOLERANCES

- A. Construct formwork so that concrete surfaces will conform with the following tolerances:
  - 1. Variation from Plumb:
    - a. In any 10 feet of length: 1/4 inch.
    - b. Maximum for entire length: 1/2-inch.
  - 2. Variation from the Level or Specified Grade:
    - a. In any 10 feet of length: 1/4 inch.
    - b. Maximum for entire length: 1/2-inch.
  - 3. Variation of the Linear Building Lines from Established Position in Plan and Related Position of Columns, Walls, Grade Beams and Partitions:
    - a. In any 20 feet of length: 1/2-inch.
    - b. Maximum for entire length: 1 inch.
  - 4. Variation in the Sizes and Locations of Sleeves, Floor Openings, and Wall Openings: 1/4-inch plus or minus.
  - 5. Variation in Cross-sectional Dimensions of Columns and Beams and in the Thickness of Slabs and Walls:
    - a. Minus: 1/4-inch.
    - b. Plus: 1/2-inch.



6. Footings (tolerances apply to concrete dimensions only, not to positioning of reinforcing steel):
  - a. Variations in dimensions in plan:
    - 1) Minus: 1/2-inch.
    - 2) Plus: 1 inch.
  - b. Misplacement: 1 inch.
  - c. Thickness:
    - 1) Decrease in thickness: 1/2-inch.
    - 2) Increase in thickness: No limit
7. Variations in Steps:
  - a. In flight of stairs:
    - 1) Rise: 1/8 inch plus or minus.
    - 2) Tread: 1/4 inch plus or minus.
  - b. In consecutive steps:
    - 1) Rise: 1/16 inch plus or minus.
    - 2) Tread: 1/8 inch plus or minus.

### **3.06 FORM SURFACE PREPARATION**

- A. Clean surfaces of forms and embedded material of all accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.
- B. Before placing the reinforcing steel or the concrete, cover the surfaces of the forms with an acceptable coating material that will effectively prevent absorption of moisture, prevent bond with the concrete, and not stain the concrete surfaces.
- C. Do not allow form coating material to stand in puddles in the forms.
- D. Form coating material shall not come in contact with hardened concrete against which fresh concrete is to be placed.
- E. Spray form coating on all concrete form surfaces, including wood forms for wall openings, keyway strips, and chamfer strips. Apply coatings in accordance with manufacturer's instructions.

### **3.07 RE-USE OF FORMS**

- A. Clean and repair surfaces of forms to be re-used.
- B. Do not use split, frayed, delaminated, or otherwise damaged form facing material.

### **3.08 FORM REMOVAL**

- A. Time specified below in this Article represents cumulative time during which temperature of concrete is maintained above 50 degrees F (10 degree C) and for concrete without set-controlling admixtures.
  1. Reduce removal time in half for high-early strength cement concrete.
- B. Formwork for columns, walls, sides of beams, and other parts not supporting the weight of the concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations, but not less than 24 hours after completing concrete placement and finishing.
- C. Forms and shoring used to support the weight of concrete in beams, slabs, and other structural members shall not be removed in less than 10 days and not until the concrete has attained 3,500 psi minimum compressive strength. Determine compressive strength by field-cured specimens.
- D. Once forms and shoring supporting beams, slabs, and other structural members have been removed, reshore concrete structural members at each level the same day such that all superimposed loads are uniformly distributed and transferred directly to the foundation through temporary supports.
  1. No construction or other live loads shall be permitted on the members, unless sufficient support is in place or concrete has attained full design strength and loads do not exceed the design maximum, as approved by Engineer.

- E. Contractor shall be responsible for all damage resulting from removal of forms or premature overloading of structural members.
- F. Loosen wood forms for wall openings as soon as possible without damage to the concrete.

**END OF SECTION**

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## SECTION 03 20 00

### CONCRETE REINFORCING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Furnish and install concrete reinforcement.

##### 1.02 REFERENCES

- A. ACI:
  - 1. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials
  - 2. 301 - Specifications for Structural Concrete for Buildings
  - 3. 315 - Details and Detailing of Concrete Reinforcement
- B. CRSI Manual of Standard Practice

##### 1.03 SUBMITTALS

- A. Submit complete Shop Drawings and bar lists of all material to be furnished and installed under this Section.
  - 1. Show bar sizes, spacing's, locations, and quantities of reinforcing and bending details.
- B. Provide Shop Drawings in accordance with ACI 315 and the CRSI Manual of Standard Practice.
  - 1. Show in detail the location, size, spacing, bends, and quantities of each and all reinforcing bars to be placed in the structure.
  - 2. Bars shall have unique identifying labels or marks for each size, length, bend configuration, etc.
- C. Submit Product Data on threaded dowel inserts.
- D. Submit mill certifications for concrete reinforcement at time of delivery.
- E. Submit certification for the epoxy coating at the time of delivery.
  - 1. Documentation of certification data shall come directly from the manufacturing plant's quality control office.
  - 2. Certification data shall contain test data and measurements taken at times and locations approved by Engineer.
  - 3. Monitoring shall be done by personnel not directly involved in production and be sufficient for compliance with approved procedures.

##### 1.04 QUALITY COMPLIANCE

- A. Comply with ACI 117, ACI 301, and ACI 315, except as modified in this Section.

##### 1.05 PRODUCT HANDLING

- A. Deliver reinforcement to the Site bundled, tagged, and marked.
  - 1. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement Drawings.
- B. Store reinforcement at the Site in a manner to prevent damage from drainage and accumulation of dirt and excessive rust.
- C. Do not store reinforcement, supports, or equipment on finished slabs.

- D. Store metal bar supports in a weather-proof shelter.
- E. Repair coating damage due to shipping, handling, and placing with an epoxy paint or equivalent coating material approved by Engineer.
  - 1. Damaged areas shall not exceed 2 percent of the surface area per linear foot of each bar.
  - 2. Coating color fading will not be considered coating damage.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Reinforcing Bars: Deformed billet steel bars conforming to ASTM A615, Grade 60.
- B. Welded Wire Fabric: Steel wire spot welded at intersections conforming to ASTM A185. Use flat sheets only.
- C. Epoxy-Coated Reinforcing Steel: Conform to ASTM A775.

### **2.02 ACCESSORIES**

- A. Bar Supports for Elevated Slabs, Walls, Columns, and Beams: All bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place shall be plastic protected, conforming to CRSI Class 1 protection for bar supports.
- B. Ground Supported Reinforcing:
  - 1. All supports for ground supported reinforcement shall conform to CRSI Class 1 protection for bar supports.
  - 2. All supports shall be supplied with precast concrete blocks with a minimum bearing surface of 100 square inches to prevent the support from sinking.
- C. Tie Wire for Reinforcing Bars: Black annealed wire, 16 gage or heavier.
- D. Tie Wire for Epoxy-Coated Reinforcing Bars: 16 gage or heavier annealed wire epoxy-coated or other polymer approved by Engineer.
- E. Threaded Dowel Inserts: Manufactured of minimum Grade 60 steel and shall be capable of achieving 125 percent of specified yield strength of reinforcement steel for the bar size indicated.
- F. Mechanical Bar Splices:
  - 1. Manufactured of minimum Grade 60 steel.
  - 2. Shall achieve 125 percent of specified yield strength of reinforcement steel for the bar size indicated.
- G. Wire Supports for Epoxy-Coated Reinforcement: Supports shall be coated with dielectric material including epoxy or other polymer for a minimum of 2 inches from the point of contact with epoxy-coated reinforcement.

### **2.03 FABRICATION**

- A. Shop fabricate reinforcing steel to required shapes and dimensions.
- B. Do not rebend or straighten reinforcing steel.
- C. Fabricate bars in accordance with the fabricating tolerances given in ACI 315.

## 2.04 FINISHES

- A. Epoxy coating shall be applied in a fusion bonded coating plant that has been granted "Certification" by CRSI (Concrete Reinforcing Steel Institute).

## PART 3 EXECUTION

### 3.01 PLACING

- A. Place reinforcing steel in accordance with the Structural Drawings, approved Shop Drawings, and as specified herein.
- B. Reinforcing steel shall have the following concrete cover, unless specifically noted differently on the Drawings:
  - 1. Concrete cast against earth 3 inches.
  - 2. All other concrete 2 inches.
- C. Properly position reinforcing steel and wire it together at intersections and supports to ensure against displacement during concrete placing. Tie all reinforcing steel to wall forms.
- D. Support reinforcing steel for slabs on grade by placing the top of precast concrete blocks, flush with grade, at all locations where chairs are to be located. Place chairs or standees over concrete blocks.
- E. Wire dowels in place before placing concrete.
- F. Place and tie all reinforcing steel before concrete is placed.
- G. Do not bend reinforcing steel embedded in hardened or partially hardened concrete after placing.
- H. Place wall chairs at the top and bottom of all walls and not greater than 6 feet on center horizontally.
- I. All reinforcement at the time concrete is placed shall be free of mud, oil, or other materials that may adversely affect or reduce the bond.
- J. Support the reinforcing steel closest to the formed surface with chairs and bolsters. Support beam stirrups and column ties by chairs.
- K. After completing welds on epoxy-coated reinforcement, repair damaged coating in accordance with the requirements stated in Part 1 of this Section.
- L. Reinforcement used as supports with epoxy-coated reinforcement shall be epoxy coated.
- M. After field bending or straightening epoxy-coated reinforcing bars, repair coating damage in accordance with Part 1 of this Section.
- N. When epoxy-coated reinforcing bars are cut in the field, coat the ends of the bars with the same material used for repair of coating damage, and repair any coating damage in accordance with Part 1 of this Section.

### 3.02 SPLICES

- A. Provide reinforcement splices by lapping ends, placing bars in contact, and tightly wire tying. Provide lap splice lengths as shown on the Drawings.
- B. Provide splices only as shown on the Drawings or as authorized by Engineer.
- C. Provide threaded or other approved mechanical bar splices:
  - 1. Where shown on the Drawings.

2. Elsewhere for the convenience of the Contractor at no additional cost to Owner if specifically requested of and approved by Engineer.

### **3.03 TOLERANCES**

- A. Place bars to the tolerances specified in ACI 117.

### **3.04 FIELD QUALITY CONTROL**

- A. Comply with requirements of Section 01 45 10 for testing and special inspection frequency and responsibilities.
- B. Inspect reinforcing steel and placement for conformance with the plans, approved shop drawings, and tolerances per ACI 117.
- C. Inspect welding of reinforcing steel in accordance with AWS D1.4 and IBC Table 1705.2.2 Item 2.b.

**END OF SECTION**

## SECTION 03 30 00

### CAST-IN-PLACE CONCRETE

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Furnish and install all cast-in-place concrete and accessories.
- B. Furnish and install subslab vapor barrier under all finished floors on grade.
- C. Related Sections:
  - 1. Section 03 11 00 - Concrete Forming
  - 2. Section 03 20 00 - Concrete Reinforcing
- D. The following is not included in this section:
  - 1. Foundation insulation
  - 2. Sheet waterproofing
  - 3. Foundation drainage

##### 1.02 REFERENCES

- A. ACI:
  - 1. 301 - Specifications for Structural Concrete
  - 2. 302.1R - Guide to Concrete Floor and Slab Construction
  - 3. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete
  - 4. 305.1 - Specification for Hot Weather Concreting
  - 5. 306.1 - Standard Specification for Cold Weather Concreting
  - 6. 309R - Guide for Consolidation of Concrete
  - 7. 318 - Building Code Requirements for Structural Concrete
  - 8. 350 - Code Requirements for Environmental Engineering Concrete Structures
- B. ASTM:
  - 1. A36 - Standard Specification for Carbon Structural Steel
  - 2. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
  - 3. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  - 4. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
  - 5. C33 - Standard Specification for Concrete Aggregates
  - 6. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
  - 7. C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
  - 8. C94 - Standard Specification for Ready-Mixed Concrete
  - 9. C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
  - 10. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
  - 11. C150 - Standard Specification for Portland Cement
  - 12. C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
  - 13. C171 - Standard Specification for Sheet Materials for Curing Concrete
  - 14. C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
  - 15. C260 - Standard Specification for Air-Entraining Admixtures for Concrete
  - 16. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
  - 17. C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
  - 18. C494 - Standard Specification for Chemical Admixtures for Concrete



19. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
20. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
21. C979 - Standard Specification for Pigments for Integrally Colored Concrete
22. C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars
23. C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
24. C1116 - Standard Specification for Fiber-Reinforced Concrete
25. C1202 - Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
26. C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures
27. C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
28. C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
29. C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
30. C1567 - Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
31. C1585 - Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes
32. C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
33. C1609 - Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)
34. C1611 - Standard Test Method for Slump Flow of Self-Consolidating Concrete
35. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
36. D2240 - Standard Test Method for Rubber Property—Durometer Hardness
37. D7508 - Standard Specification for Polyolefin Chopped Strands for Use in Concrete
38. E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
39. E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

### 1.03 SUBMITTALS

- A. Submit manufacturer's data for concrete admixtures, liquid curing material (if allowed in writing by Engineer), floor joint filler, finishing compounds, bonding agents, and adhesive anchoring material. Note that liquid curing material is allowed as a substitute for damp curing only with permission of the Engineer unless noted otherwise.
- B. Submit concrete aggregate test reports and concrete mix designs at least 14 days prior to placement of concrete.
  1. Aggregate tests: Test aggregates for compliance with ASTM C33
  2. Concrete mix design:
    - a. Prepare mix designs for each type of concrete specified. See Table 2-1 at end of this Section.
    - b. Design concrete mixes in accordance with ACI 301.
    - c. Provide strength results of trial batches or historical test data.
- C. Submit results of concrete strength tests.
- D. Submit documentation from Ready-mix Supplier showing shrinkage within specified limits per ASTM C157, as modified herein. Begin tests as soon as possible and submit results to Engineer for at least three specimens.
- E. Retain the above paragraph if specifying maximum allowable shrinkage of concrete mixes. Test takes 35 days minimum.
  1. Typical shrinkage = 0.05 percent.
  2. Can get 0.04 percent by reducing paste and water.

3. Can get 0.03 percent with special attention to aggregate gradation.
  4. Can get 0.02 percent with shrinkage reducing chemical admixtures.
  5. Can get < 0.02 percent with shrinkage-compensating cement at a cost of about \$20/cy.
- F. Submit written procedure for removal of dissipating resin curing compound residue, if it is allowed by the Engineer.
- G. Where not shown on the Drawings, submit joint locations and placement plan.

#### 1.04 QUALITY ASSURANCE

- A. Comply with ACI 301, except as modified in this Section.
- B. Source limitations: Obtain each type of cementitious material from the same manufacturer. Obtain each type of admixture from the same manufacturer. Obtain aggregate from single source.
- C. Qualifications:
1. Ready mix supplier: minimum 5 years' experience in making concrete.
  2. Contractor: minimum 3 years' experience in forming, placing, and finishing concrete. Foreman: competent, in charge of work at all times, for duration of work unless permitted in writing by Owner and Engineer.
- D. An independent testing laboratory will be retained by the Owner to perform the work listed below. All costs for this testing shall be paid by Owner except as noted for re-tests:
1. Test proposed aggregate.
  2. Test slump and temperature.
  3. Cast concrete cylinders for strength tests.
  4. Test concrete cylinders.
- E. Concrete Mix Design:
1. Concrete Supplier shall prepare mix designs for each type of concrete specified.
  2. Design concrete mixes in accordance with ACI 301.

#### 1.05 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the Project Site.
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.
  2. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete Subcontractor and their superintendent.
    - e. Special concrete finish Subcontractor and their superintendent.
  3. Review all concrete procedures and materials including:
    - a. special inspection and testing and inspecting agency procedures for field quality control
    - b. concrete finishes and finishing
    - c. Shrinkage control and joint spacing
    - d. Cold- and hot-weather concreting procedures
    - e. Curing procedures
    - f. Construction contraction and isolation joints, and joint-filler strips
    - g. Forms and form removal limitations
    - h. Vapor-retarder installation
    - i. Steel reinforcement installation
    - j. Concrete protection
  4. Minutes of the meeting shall be recorded, typed and printed by the contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall also be transmitted to the following for information purposes:
    - a. Owner's representative
    - b. Resident engineer

- c. Consultant engineer
5. The minutes shall include a statement by the concrete contractor indicating that the proposed mix design(s), and placing, finishing and curing procedures can produce the concrete quality required by these specifications.

## 1.06 PRODUCT HANDLING

- A. Do not store forms, shores, reinforcing, equipment, or other material on finished slab surfaces.
- B. Waterstops: store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- C. Joint Filler, Joint Sealer, Void Forms, and Curing Materials: Deliver in original factory packaging and unopened containers. Protect from damage and contamination.

## PART 2 PRODUCTS

### 2.01 CONCRETE MATERIAL

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures and macro synthetic fibers from single source from single manufacturer.
- B. Cementitious Materials
  1. Portland Cement: Conform to ASTM C150, Type I. Other types may be submitted for approval where justified by a particular need.
    - a. Alkali content less than or equal to 0.6 percent (expressed as Na<sub>2</sub>O).
  2. Blended Hydraulic Cement: Conform to ASTM C595, Type IL (Portland Limestone Cement), IS, IP, and IT.
  3. Fly Ash: ASTM C618, Class C or F. Loss on ignition shall be limited to 3 percent maximum. Minimum CaO shall be demonstrated by test to be 18 percent. See also Structural Notes.
  4. Slag Cement: ASTM C989, Grade 100 or 120.
  5. Silica Fume: ASTM C1240, 6 percent maximum.
    - a. Acceptable products:
      - i. Master Builders Solutions US LLC; MasterLife SF 100.
  6. Metakaolin: ASTM C618, Class N.
    - a. Acceptable products:
      - i. MetaMax; BASF Kaolin (part of BASF Corporation).
- C. Aggregate:
  1. Coarse Aggregate: ASTM C33-5S:
    - a. For exterior exposed surfaces.
  2. Fine Aggregate: ASTM C33:
    - a. For exterior exposed surfaces.
  3. Do not use fine or coarse aggregates containing spalling-causing deleterious substances.
  4. Local aggregates not complying with ASTM C33 but which have been shown by special test or actual service to produce concrete of adequate strength and durability may be used when approved by Engineer.
  5. Maximum Size (least of the following):
    - a. 1/5 the narrowest dimension of concrete member;
    - b. 1/3 the depth of slab;
    - c. 3/4 the clear spacing between reinforcement bars;
    - d. 1-1/2 inches
  6. Gradation sizes 467, 57 or 67: ASTM C33, Table 2. Mass Concrete shall use gradation sizes 357 or 467.
  7. Maximum aggregate size shall be per C33. Where maximum aggregate size is implied by C33 gradations to be greater than 3/4", do not supply 3/4" (-) aggregate.
  8. Minimum total coarse aggregate content for slabs on ground and topping slabs shall be 12 cubic feet per cubic yard for 1 1/2 inches or larger top size aggregate; 11.5 cubic feet per cubic yard for

- top size aggregate 1 1/4 inches or larger but less than 1 1/2 inches; 11 cubic feet per cubic yard for top size aggregate 1 inch or larger but less than 1 1/4 inches; or 10.5 cubic feet per cubic yard for top size aggregate less than 1 inch.
9. Combined aggregate gradation for slabs on ground, topping slabs, and other designated concrete shall be 8 percent - 18 percent for large top size aggregates (1½ in.) or 8 percent - 22 percent for smaller top size aggregates (1 in. or ¾ in.) retained on each sieve below the top size and above the No. 100.
- D. Water: ASTM C1602. Clean and free from deleterious amounts of oil, acid, alkali, or other foreign matter. Potable or demonstrated to have no harmful effects on concrete.

## 2.02 ADMIXTURES

- A. Provide admixtures certified by the manufacturer to be compatible with other admixtures and not containing intentionally added chlorides.
- B. Air Entraining Admixture: ASTM C260.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterAir Series.
- C. Water Reducing Admixture: ASTM C494, Type A.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterPozzolith Series or MasterPolyheed Series.
- D. Retarding Admixtures: ASTM C494, Type B.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterSet R Series or MasterSet DELVO Series.
- E. Accelerating Admixtures: ASTM C494, Type C.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterSet AC 534 or MasterSet FP 20.
- F. Water-Reducing and Retarding Admixtures: ASTM C494, Type D.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterSet R Series or MasterSet DELVO Series.
- G. Water-Reducing and Accelerating Admixtures: ASTM C494, Type E.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterSet FP 20.
- H. High-Range Water-Reducing Admixtures (Superplasticizer): ASTM C494, Type F.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterGlenium Series or MasterRheobuild 1000.
- I. Viscosity Modifying Admixture: ASTM C494, Type S.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterMatrix VMA Series.
- J. Workability-Retaining Admixture: ASTM C494, Type S. Shall retain concrete workability without affecting time of setting or early-age strength development.
1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterSure Z 60.
- K. Corrosion Inhibiting Admixture: ASTM C494 Type C or S. Shall be a nominal 30 percent solution of calcium nitrite or an amine/ester-based organic corrosion-inhibiting admixture.
1. Acceptable products:
    - a. Master Builders Solutions US LLC: MasterLife CI 30 or MasterLife CI 222.
    - b. CorTec MCI.
    - c. Sika CNI, FerroGard-901S

- d. Euclid Chemical Company: Eucon CIA
- L. Integral Waterproofing Admixture: integral crystalline admixture that reacts in concrete to form non-soluble crystalline hydration products in the capillary pores and cracks of the concrete. Admixture shall provide the following properties:
- 1. Water Penetration per DIN 1048 > 40 percent Reduction at 72 psi.
  - 2. Water Permeability per CRD C48-92 >70 percent Reduction at 200 psi
  - 3. Capillary Absorption per ASTM C1585 >40 percent Reduction
  - 4. Compressive Strength per ASTM C39 Equal to and up to 8 percent increase
  - 5. Resistance to Chloride Penetration per ASTM C1202 10 percent improvement
  - 6. Required for all water-retaining or water-resisting structures.
  - 7. Acceptable products:
    - a. Master Builders Solutions US LLC: MasterLife 300 Series.
    - b. Sika Corporation: WT 215-P or WT 240-P.
    - c. Euclid Chemical Company: Vandex AM-10.
    - d. Xypex.
    - e. Penetron.
- M. Shrinkage-Reducing Admixture: ASTM C494, Type S (Admixture as noted in Section 3.05).
- 1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterLife SRA Series or MasterLife CRA 007.
- N. Alkali-Silica Reaction Inhibiting Admixture: ASTM C494, Type S. Shall contain a nominal lithium nitrate content of 30 percent.
- 1. Acceptable products:
    - a. Master Builders Solutions US LLC; MasterLife ASR 30.

### 2.03 FIBER REINFORCEMENT

Fiber dosage shall be according to manufacturer's recommendation for the specific building element.

- A. Synthetic Macro-Fiber: Synthetic (Polyolefin) macro-fibers shall comply with ASTM C1116/C1116M, Type III, and ASTM D7508. Synthetic macro-fiber shall be a minimum 1-1/2-inch (38 mm) length, a minimum aspect ratio of 70, and shall provide a minimum tensile strength of 70 KSI (483 MPa). Synthetic macro-fiber shall be UL-certified for 2-hour minimum fire-resistance-rated construction when used in lieu of welded wire reinforcement in UL Design Series D700, D800, and D900 Floor-Ceiling Assemblies.
- 1. Euclid Chemical Company; Tuf-Strand SF.
  - 2. Forta-Ferro.
  - 3. Master Builders Solutions US LLC: MasterFiber MAC Series.
  - 4. Sika Corporation: Fibermesh/Novomesh.
  - 5. GCP Applied Technologies: Strux BT50.
  - 6. Euclid Chemical recommends use of UL-certified synthetic macro-fiber for the purpose of controlling temperature and drying shrinkage cracking in slabs-on-ground and suspended slabs on metal form deck. The quantity of fiber required to be included in the concrete is calculated by the fiber reinforcement manufacturer based on required performance criteria furnished by a structural engineer.
  - 7. Retain option in "Synthetic Macro-Fiber" Paragraph when synthetic macro-fiber is required for composite floor assemblies.

### 2.04 MISCELLANEOUS MATERIAL

- A. Burlap-Polyethylene Sheet: Burlap weighing not less than 10 ounces per linear yard, 40 inches wide impregnated on 1 side with white opaque polyethylene 0.006 inch thick. Sheeting shall conform to ASTM C171.

- B. Liquid Curing Compound: ASTM C309, Type 1-D, Class B clear or translucent with fugitive dye. Do not apply to floor slabs. In general, liquid curing compound may not be used in place of water cure with burlap and poly without written permission of SER.
- C. Expansion Joint Material: Bituminous fiber type conforming to ASTM D1751 with bituminous or paraffin binder.
- D. PVC Waterstops:
  - 1. Ribbed type with centerbulb.
  - 2. Material: Virgin PVC.
  - 3. Minimum Thickness: 3/16 inch.
  - 4. Greenstreak Plastic Products Company, specification grade, or approved equal.
  - 5. Install 4-inch width for construction joints located flush with slab or wall:
    - a. Centerbulb diameter: 3/4 inch minimum.
  - 6. Install 6-inch width for all other construction joints, unless otherwise noted:
    - a. Centerbulb diameter: 15/16 inch minimum.
  - 7. Water Stop Joints: Manufacturer's standard prefabricated joints at intersection points and corners, or field welded joints subject to inspection by and approval of Engineer's on-site representative.
- E. Hydrophilic Waterstops. In general, hydrophilic waterstop is not a substitute for PVC waterstop. Use only with written permission of SER and written recommendation of manufacturer's representative.
  - 1. Rubber Concrete Joint: Volclay Akwastop in accordance with manufacturer's recommendations, or approved equal.
  - 2. CETCO Waterstop-RX, installed per manufacturer's specification with approved bonding agent.
    - a. Waterstop-RX 101 or RX 101T for use in concrete 8" thick or greater and with 2 mats of reinforcement.
    - b. Waterstop-RX 102 in vertical concrete 6" thick or greater and horizontal concrete 4 inches thick or greater.
- F. Interior Joint Filler: Multi-component, fast-curing, semi-rigid polyurea sealant:
  - 1. Meet or exceed ASTM D 2240.
  - 2. Shore A hardness 90 to 95.
  - 3. Products:
    - a. Dymerica 240FC by Tremco
    - b. L&M Joint Tite 750 (Laticrete)
    - c. Euco QwikJoint UVR by Euclid Chemical
    - d. MasterSeal CR100 by Master Builders Solutions US LLC.
    - e. PlaniSeal Rapid Joint 15 by Mapei
    - f. Approved equal.
- G. Exterior Joint Sealant: 2 parts, self-leveling, polyurethane sealant:
  - 1. MasterSeal SL 2 by Master Builders Solutions US LLC.
  - 2. Eucolastic 1SL manufactured by Euclid Chemical
  - 3. MapeFlex PU30 by Mapei
  - 4. Approved equal.
- H. Bonding Agent: Nonredispersible acrylic emulsion formulated as admixture to produce polymer modified concrete. Products may be applied directly to properly prepared substrates or as an admixture in cement or cement-sand slurries.
  - 1. Euclid AKKRO-7T
  - 2. MasterEmaco ADH series by Master Builders Solutions US LLC
  - 3. Sika Armatec 110 or Sika-Dur 32
- I. Adhesive for anchoring steel reinforcement dowels and threaded rods in concrete: 2 component injected epoxy structural adhesive. Refer to General Structural Notes of the drawings, section "Post Installed Anchor Rods and Dowels" for approved products and additional information.

- J. Epoxy Injection: Two component, high modulus, pre-proportioned moisture insensitive, VOC compliant 100 percent solids epoxy adhesive. Product shall conform to ASTM C881 Type I and IV, Grade 1, Class C. Install per manufacturer's recommendations.
  - 1. MasterInject 1380 by Master Builders Solutions US LLC.
  - 2. Euclid DURAL 452 LV with DURAL 452 Gel
  - 3. Sika 35, Hi-Mod, LV or equal with Sikadur 31 Paste Epoxy.
- K. Plastic Coated Manhole Rungs: Copolymer Polypropylene Plastic in accordance with ASTM C478 and ASTM A615 as manufactured by M.A Industries, Inc., or approved equal.
- L. Dovetail Anchor Slot: 18 gage stainless steel. Carbon steel is not acceptable.
- M. Sub-Slab Vapor Barrier: ASTM E1745, Class A, minimum 10 mils thick polyethylene film. Water vapor transmission of 0.00 or perm level of 0.01. Joints welded or lapped and sealed according to manufacturer's recommendations.

## 2.05 CONCRETE MIX PROPORTIONS

- A. See Table 2-1 at the end of the Section.
- B. Self-consolidating concrete may be used for all architectural concrete and heavily reinforced members as shown on the drawings. All self-consolidating concrete shall contain the specified high-range water-reducing admixture and viscosity-modifying admixture where required. Minimum spread of 22 inches - 30 inches when measured in accordance with ASTM C 1611 or as required by the successful test placement. The workability, pumpability, finishability, and setting time of the proposed mix design shall be verified with a successful test placement onsite.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing, or high-range water-reducing admixture in concrete, as required, for placement and workability.
  - 2. Use water-reducing and -retarding admixture or hydration stabilizer when required by high temperatures, low humidity, or other adverse placement conditions.
  - 3. Use water-reducing and -accelerating admixture when required by low temperatures or other adverse winter placement conditions.
  - 4. Use water-reducing or high range water reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, macro fiber reinforced concrete, and concrete with a w/c ratio below 0.50.
  - 5. Use non-chloride accelerator for all concrete, less than 8 inches thick, placed at air temperatures below 50 degrees Fahrenheit.
  - 6. Use alkali-silica reactivity inhibitor unless ready mix company confirms that the aggregates to be used on the job are non-reactive per ASTM C1260, ASTM C1567 or ASTM C1293.
  - 7. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
  - 8. Use shrinkage-reducing admixture or shrinkage-compensating admixture where indicated on drawings or as required to keep shrinkage below specified limits per ASTM C157.
  - 9. Use Integral Waterproofing Admixture in concrete where indicated.
- D. Synthetic Macro Fiber Reinforcement.
  - 1. Slabs-on-ground, topping slabs, shotcrete, and precast units
    - a. Submit fiber manufacturer's documentation indicating Fe<sub>3</sub> value that proposed fiber dosage will provide per ASTM C1609. Under no circumstances shall dosage rate be less than 3.0 pounds per cubic yard of concrete.
      - 1) Fe<sub>3</sub> shall be defined as the RDT150/Re<sub>3</sub> (as determined through ASTM C1609 testing) multiplied by the flexural strength (Fr) of the concrete tested.
        - a)  $Fe_3 = RDT150 \times Fr$
  - 2. The structural synthetic macro fibers do not replace any reinforcing shown over beams to control cracks from negative moments, nor reinforcing at re-entrant corners required by details in drawings.

## **PART 3 EXECUTION**

### **3.01 CONCRETE PRODUCTION**

- A. Ready-mixed concrete: Comply with ASTM C94:
  - 1. Measured from the time water and cement are batched together, no more than 90 minutes shall elapse until concrete is placed.
  - 2. This time shall be reduced by two minutes for every degree that concrete temperature exceeds 75 degrees Fahrenheit unless non-chloride set retarders are used.
  - 3. These requirements may be relaxed through the use of set-controlling admixtures. Submit proposed admixture and dosage to the Engineer for review.
  - 4. Batch Ticket: Provide for each batch discharged and used in work, indicating project identification name and number date, mix type, mix time, quantity and amount of water introduced and available.
- B. Mix concrete only in quantities for immediate use. Concrete which has set shall be discarded and shall not be retempered.
- C. Do not add water at the Site without the approval of Engineer. In no case shall water be added in excess of that in the approved mix design.
- D. Add admixtures and mix concrete in accordance with manufacturer's specification.

### **3.02 PLACING WATERSTOP**

- A. Place waterstop material at all construction joints, unless shown otherwise and confirmed by Engineer.
- B. Place waterstop in the joint and between each layer of reinforcing steel with each half embedded in concrete. Waterstop shall be minimum 3 inches clear of reinforcing, preferably centered in the member. Tip of waterstop may touch reinforcing which lies perpendicular to waterstop. Secure waterstop by hog-tying waterstop to protection bar (refer to Drawings) at 12 inches on center prior to placing concrete.
- C. Thoroughly and systematically vibrate concrete around the waterstop to ensure positive contact between concrete and waterstop. When concrete is being placed, take care not to deflect waterstop out of proper position.
- D. Use prefabricated waterstop fittings or follow proper field splicing procedures for all connections and splices:
  - 1. Miter all intersecting connections at 45 degrees.
  - 2. Use a thermostatically controlled heating iron to heat both ends of waterstop to be connected, then butt splice pieces to be joined with full contact.
  - 3. TPER waterstop shall use factory splices at all except straight butt joints.
- E. Follow manufacturer's recommendations for proper preparation and installation of waterstop material.

### **3.03 EMBEDDED ITEMS**

- A. Place all sleeves, inserts, anchors, and embedded items required for adjoining work or for its support prior to placing concrete.
- B. Position all embedded items accurately and supported against displacement.
- C. Temporarily fill voids in sleeves, inserts, and anchor slots with readily removable material to prevent the entry of concrete into the voids.
- D. See Structural Notes for conduit and aluminum items to be embedded. Conduit penetrating a wall or structural slab shall be spaced at three diameters minimum center to center.



### 3.04 PREPARATION BEFORE PLACING

- A. Complete formwork, true to lines required, and secure all reinforcement and embedded items in place.
- B. Remove all snow, ice, laitance, and mud prior to placing concrete.
- C. Do not place concrete on frozen ground. Do not place concrete around reinforcing which is muddy or colder than 40 degrees Fahrenheit.
- D. Do not place concrete on ground with standing water or when upper 2 inches of ground is saturated.
- E. Do not place concrete during rain, sleet, or snow.

### 3.05 JOINTS IN CONCRETE STRUCTURES

- A. Because of the effects of aggregate size and gradation, concrete consolidation, workmanship, detailing, cure, and other factors; contractor is responsible for cracking in base slabs and walls of liquid-holding structures, and shall repair any leaking cracks by sealing, injecting, or otherwise filling them. Where sealing is judged necessary by either contractor or engineer, contractor shall submit material and description of sealing to be used for review by engineer. Note that crystalline waterproofing as specified will heal tight cracks (less than approximately 1/64") over time in warm temperatures, but wide cracks or leak tests attempted in cold temperatures or with cold water will require additional measures. Any wall which is or may be subject to external groundwater is considered liquid holding.
- B. Concrete walls in liquid-holding structures shall have waterstopped construction joints at a maximum spacing of 25 feet for concrete proportioned according to these notes and the specification. Full horizontal reinforcing shall extend through these joints and be developed each side of joint. At least 72 hours shall pass between adjacent wall pours in liquid-holding structures. Joint spacing in walls shall be measured between corners in a straight line or along a curve, but not around corners. For this purpose, a T-intersection counts as a corner at the intersecting wall but not at the continuing wall.
- C. Alternatively, a low-shrinkage mix may be proposed and shrinkage measured for the specific concrete mix to be used in the walls, and the maximum construction joint spacing determined by the equation  $\text{Spacing} = 1.50/\text{sh}$ , where "sh" is the shrinkage in percent from the 35 day shrinkage test described below; and the spacing is limited to 50 feet. Concrete placed in the walls shall have the same or lesser water content as that used in the test. Measurement of shrinkage shall be according to ASTM C157, except that the specimens should be moist cured (burlap and poly) for 7 days as required for in situ concrete rather than soaked in a lime-saturated bath for 28 days. Shrinkage shall be reported based on measurements at the end of the 7-day moist cure, and at 28 days after cessation of moist curing.
- D. Concrete base slabs in liquid-holding structures shall have waterstopped construction joints at a maximum spacing of 50 feet in each direction, with full reinforcing through the joint and developed each side of each joint. At least 72 hours shall pass between adjacent slab pours in liquid-holding structures.
- E. Alternatively, shrinkage may be measured as specified above for the specific concrete mix to be used in the base slab, and the maximum spacing determined by the equation  $\text{Spacing} = 3.0/\text{sh}$ , where "sh" is the shrinkage in percent from the 35 day shrinkage test described above and the spacing is limited to 100 feet. Concrete placed in the base slab shall have the same or lesser water content as that used in the test.
- F. Concrete walls in non-liquid-holding structures shall have construction or contraction joints at a maximum spacing of 60 feet. Footings carrying such walls shall have construction or contraction joints at a maximum spacing of 120 feet. Half the longitudinal reinforcing shall be interrupted at these joints.
- G. Contraction/construction joint spacing in non-liquid-holding steel-reinforced slabs on ground (building floors) shall be spaced at a maximum of  $24 \times \text{thickness}$ , but not more than 15 feet, in each direction.

Joint spacing in fiber-reinforced slabs on ground shall be spaced at a maximum of 30 x thickness, but not more than 18 feet, in each direction. A slab of dimension 20 feet or less does not need to be divided by a joint in that direction except as required by aspect ratio. The aspect ratio of any panel shall not exceed 1.50. Unless noted on drawings, contractor shall submit proposed contraction/construction joint spacing for review. Joints shall intersect columns. Where slab is reinforced with bars #4 or greater, cut or interrupt every other bar at each joint. Contraction joint depth shall be slab thickness/4, with a minimum of 1". If sawcut, joints shall be cut as soon as it is possible to do so without raveling the concrete, but no later than 12 hours after placement.

- H. Contraction joint spacing in steel-reinforced slabs on ground (building floors) with two mats of reinforcing shall have a 1 1/2-inch chamfer strip at bottom of slab and a sawcut or formed joint 1 1/2-inch deep at same location, top of slab. Cut or interrupt every other bar in each mat at each contraction/construction joint.
- I. Construction joints in building floor slabs on ground shall provide for shear transfer across the joint, using plate dowels such as diamond dowels. Round or square dowel rods shall not be used. Reinforcing bars may be used where shown on drawings, e.g. At stoop or apron joints. Plate dowels shall be sized per manufacturer's recommendations and spaced at manufacturer's recommended spacing (18 inches max for wheeled traffic on slab, 24 inches max otherwise). If subject to de-icing salt, plate dowels shall be galvanized or epoxy coated.
- J. Space control joints at maximum 10'-0" on center each way for topping slabs on precast plank.

### **3.06 CONCRETE CONVEYING**

- A. Deliver concrete from the mixer to the place of final deposit as rapidly as practical by methods which will prevent segregation or loss of ingredients.

### **3.07 CONCRETE DEPOSITING**

- A. Deposit concrete continuously or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.
- B. Place concrete at such a rate that the concrete which is being integrated with fresh concrete is still plastic.
- C. Do not deposit concrete which has partially hardened or has been contaminated by hardened materials.
- D. Remove rejected concrete from the Site.
- E. Deposit concrete as nearly as practicable in its final position to avoid segregation due to handling or flowing.
- F. Free fall of concrete shall not exceed 4 feet for conventional concrete, 10 feet for concrete containing high range water reducing admixture and 15 feet for self-consolidating concrete. Use chutes equipped with hopper heads for placing where a drop of more than this is required.

### **3.08 PLACING CONCRETE SLABS**

- A. Verify Vapor Barrier is fully installed (where required for floor slab on ground) and undamaged:
  - 1. Install per ASTM E1643.
  - 2. Place membrane over compacted fill; minimum number of joints.
  - 3. Overlap sheets, minimum 12 inches of lap and seal joints with tape in accordance with manufacturer's recommendation.
- B. Deposit and consolidate concrete slabs in a continuous operation.

- C. Consolidate concrete placed in slabs by vibrating bridge screeds, roller pipe screeds, or other methods acceptable to Engineer:
  1. Bring slab surfaces to the correct level with a straight edge and then strike off.
  2. Use bullfloats or darbies to smooth the surface, leaving it free from bumps and hollows.
- D. Do not leave screed stakes in concrete.
- E. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to start of finishing operations.

**3.09 COLD WEATHER PLACING**

- A. Do not place concrete when the air temperature is less than 40 degrees Fahrenheit without the specific approval of Engineer and without a cold-weather plan including heating and blanketing, as required.
- B. Cold Weather Concrete Work: ACI 306.1, except as modified by the requirements of these Contract Documents.
- C. Do not place concrete against any frozen substrate, including subgrade soils and surfaces of formwork.
- D. Do not place concrete around any embedment, including reinforcing steel that is at a temperature below freezing.
- E. The temperature of the concrete delivered at the site shall conform to the following Minimum Temperature limitations. Mass concrete shall conform to Maximum Placement Temperature requirements of mix design.

Air Temperature	Minimum Concrete Temperature	
	< 12 Inches Thick	12-29 Inches Thick
Above 30° Fahrenheit	60° Fahrenheit	55° Fahrenheit
0° to 30° Fahrenheit	65° Fahrenheit	60° Fahrenheit
Below 0° Fahrenheit	70° Fahrenheit	65° Fahrenheit

- F. If water or aggregate is heated above 100 degrees Fahrenheit, combine water with the aggregate in the mixer before cement is added. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 degrees Fahrenheit.
- G. When the mean daily temperature is less than 40 degrees Fahrenheit, apply heat as required to maintain the temperature of the concrete between 50- and 70-degrees Fahrenheit for the required curing period. This requirement may be modified for Mass Concrete (greater than 29 inches in thickness) and concrete approaching dimensions of Mass Concrete, based on an approved Thermal Control and Placement Plan.
- H. Arrangements for heating, covering, Insulation, or housing the Concrete Work:
  1. Made in advance of placement.
  2. Adequate to maintain the required temperature without injury due to concentration of cold or heat.
  3. Keep temperature within enclosure even within 15 degrees Fahrenheit at all locations.
  4. Keep protection in place for a minimum of 7 days or until low ambient temperatures are 50 degrees or above for remainder of 10-day curing period.
  5. Keep protection in place a minimum of 24 hours after cessation of heating to allow for gradual cooldown. For Mass Concrete (greater than 29 inches in thickness) and concrete approaching dimensions of Mass Concrete this period will be longer, based on an approved Thermal Control and Placement Plan.
- I. Do not use open combustion heaters, unless precautions are taken to prevent exposure of the concrete to exhaust gases.

- J. Once the cold weather concrete protection is removed, continue concrete curing for the remainder of the curing period.

### **3.10 HOT WEATHER PLACING**

- A. Comply with ACI 305.1 when hot weather conditions exist.
- B. Maintain concrete temperature at time of placement below 90 degrees Fahrenheit.
- C. When the temperature of the steel is greater than 120 degrees Fahrenheit, spray steel forms and reinforcement with water prior to placing concrete.
- D. Keep all surfaces protected from rapid drying. Provide windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering in advance of placement.
- E. Submit Hot Weather Placement Plan when (forecast high temperature, degrees F) - (relative humidity, %) + (forecast wind velocity, mph) is greater than 50. Plan shall include elements from D. above as deemed necessary.

### **3.11 CONSOLIDATION**

- A. Consolidate all concrete in accordance with provisions of ACI 309R.
- B. Consolidate each layer of concrete immediately after placing by use of internal concrete vibrators. Maintain a frequency of not less than 8,000 vibrations per minute for each internal vibrator.
- C. Provide adequate number of units and power source at all times. Use a minimum of 2 vibrators for all work and maintain spare units to ensure adequacy.
- D. Insert the vibrator so as to penetrate the lift immediately below the one being placed. Do not insert the vibrator into lower courses which have begun to set.
- E. Limit spacing between insertions of the vibrator to 12-18 inches and do not exceed twice the radius of action as shown in ACI 309R or 18 inches.
- F. Do not use vibrators to transport concrete inside the forms.
- G. Do not vibrate self-consolidating concrete.
- H. Vibrate concrete to minimize entrapped air and surface voids on formed surfaces.

### **3.12 CONCRETE SLAB FINISHING**

- A. Float Finish:
  - 1. Apply float finish to all slab surfaces.
  - 2. After placing and screeding concrete slabs, do not work the surface until ready for floating. Begin floating when the surface water has disappeared and when the concrete has stiffened sufficiently to permit operation of a power-driven float.
  - 3. Consolidate the surface with power-driven float or by handfloating if the area is small or inaccessible to power units.
  - 4. Check and level the surface plane to a tolerance not exceeding 1/4 inch in 10 feet when tested with a 10 foot straight-edge placed on the surface at not less than 2 different angles.
  - 5. Immediately after leveling, refloat the surfaces to a smooth, uniform, granular texture.
- B. Trowel Finish:
  - 1. Apply steel trowel finish to all interior surfaces such as floor slabs, topping, and stair treads and all tank slabs which do not receive a concrete topping. Note that concrete containing more than 2 percent air must be well set before troweling. It is not recommended that troweled concrete

- have more than 2 percent air. Contractor is responsible for replacing any concrete which delaminates due to high air content in conjunction with troweling.
2. Apply float finish to slabs as described above in Part 3.13.A.
  3. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
  4. Consolidate the concrete surface by the final hand troweling operation, free from trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8 inch in 10 feet when tested with a 10 foot straight-edge.
  5. Finish fiber-reinforced concrete so as to minimize visible fibers at the surface of the concrete.
- C. Broom Finish:
1. Apply non-slip broom finish to all exterior surfaces such as sidewalks, aprons, stairs, and top of tank slabs.
  2. Apply float finish to slabs as described above in Part 3.13.A.
  3. Immediately after floating, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route or span. Use a fiber-bristle broom.
  4. Finish fiber-reinforced concrete so as to minimize visible fibers at the surface of the concrete.
- D. Follow manufacturer's recommendations for finishing topping slabs with fiber reinforcing, including appropriate tools and timing. Space control joints at maximum 10'-0" on center each way for topping slabs on precast plank.

### 3.13 FINISHING FORMED SURFACES

- A. General:
1. Construct formwork in accordance with Section 03 11 00.
  2. Perform all Concrete Crack Repairs in accordance with Article 3.14.B.
  3. Remove all form release agents, curing compounds, hardeners, salts, efflorescence, laitance, loose material, unsound concrete, and other foreign materials by sandblasting, shot blasting, mechanical scarification, or other suitable methods.
  4. For filling of deep voids, bugholes, etc., exceeding the limits below, refer to Article 3.14.D.
  5. Remove all fins, seams and concrete "buttons" protruding more than 1/16 inch.
- B. Provide the following form finish to all formed surfaces not exposed to view as follows:
1. Concrete shall achieve a finish level of CSC1 (concrete surface category 1) or better as defined in the latest edition of ACI 347.3R.
  2. The following requirements are recommended to achieve CSC1:
    - a. Texture level T1:
      - 1) Acceptable gaps in adjacent formwork components less than or equal to 3/4 inch.
      - 2) Acceptable depth of mortar loss less than or equal to 1/2 inch.
      - 3) Acceptable surface offsets of panel joints up to 1 inch.
      - 4) Allowable projections 1 inch from adjacent surface.
      - 5) Form-facing material examples: Rough sawn lumber, CDX plywood, and particle board
      - 6) Imprints of modular panel frames are acceptable.
    - b. Surface void ratio level SVR1, but doesn't applied to permanently concealed concrete surfaces.
    - c. Color uniformity CU1:
      - 1) Light and dark color variations are acceptable.
      - 2) Color variations between adjacent placements and layer lines are acceptable.
      - 3) Rust and dirt stains are acceptable.
    - d. Surface irregularities level SI1:
      - 1) Maximum gradual deviation over a distance of 5 feet or abrupt deviation is 1 inch.
      - 2) Limit deflection of formwork structure to L/240.
      - 3) ACI 117-10 Section 4.8.3, Class D surface.
      - 4) ACI 117-10 Section 4.8.2 does not apply.
    - e. Construction and facing-joint level CJ1:
      - 1) Acceptable offset of surfaces between two adjacent placements less than or equal to 1 inch.

- f. Form-facing category FC1:
    - 1) Holes, greater than 3/16 inch: Plug or disc covers are acceptable.
    - 2) Holes, 3/16 inch or less: Acceptable.
    - 3) The following are acceptable: vibrator burns, scratches/dents, concrete remnants, cement residue, swelling of facing at fastener or tie holes, patching.
- C. Provide the following form finish to all formed surfaces exposed to view as follows:
- 1. Concrete shall achieve an overall finish level of CSC2 (concrete surface Category 2) or better as defined in the latest edition of ACI 347.3R.
  - 2. The following requirements are recommended to achieve CSC2; more stringent requirements are indicated with “\*”:
    - a. Texture level T2:
      - 1) Acceptable gaps in adjacent formwork components less than or equal to 1/2 inch.
      - 2) Acceptable depth of mortar loss less than or equal to 3/8 inch.
      - 3) Acceptable surface offsets of panel joints up to 1/2 inch.
      - 4) Allowable projections 1/2 inch from adjacent surface.
      - 5) Form-facing material examples: Class BBOES plywood, MDO plywood.
      - 6) Imprints of modular panel frames are acceptable.
    - b. Surface void ratio level SVR2:
      - 1) Voids not to exceed 5/8 inch in diameter.
      - 2) Void area not to exceed 1 percent of the test area.
    - c. Color uniformity CU2\*:
      - 1) Gradual light and dark color variations are acceptable.
      - 2) Color consistency between adjacent placements and layer lines should be mostly uniform.
      - 3) Rust and dirt stains are unacceptable.
      - 4) Concrete source materials and form-facing material should be of consistent type, grade, and source to avoid causing deviations in appearance.
    - d. Surface irregularities level SI2:
      - 1) Maximum gradual deviation over a distance of 5 ft or abrupt deviation is 1/2 inch.
      - 2) Limit deflection of formwork structure to L/360.
      - 3) ACI 117-10 Section 4.8.3, Class C surface.
      - 4) ACI 117-10 Section 4.8.2 does not apply.
    - e. Construction and facing-joint level CJ2:
      - 1) Acceptable offset of surfaces between two adjacent placements less than or equal to 1/2 inch.
      - 2) The use of chamfer strips or similar reveals are recommended at construction joints.
    - f. Form-facing category FC2\*:
      - 1) Holes, greater than 3/16 inch: Acceptable if patched sanded and sealed or ground to match adjacent form surface.
      - 2) Holes, 3/16 inch or less: Acceptable without patching, provided form surface is not damaged or torn around hole.
      - 3) Scratches/dents: Acceptable if patched, sanded, and sealed or ground to match adjacent form surface.
      - 4) The following are unacceptable: Vibrator burns, concrete remnants, swelling of facing at fastener or tie holes.
      - 5) The following are acceptable: Cement residue, patching.
- D. Where indicated on the Drawings, provide a special form finish to all formed surfaces exposed to view:
- 1. Prepare 3 test samples of various textures for approval by Engineer. Each sample shall be approximately 6 feet by 6 feet in size and located on an unexposed wall surface as directed by Engineer.
  - 2. Perform all Concrete Crack Repairs in accordance with Article 3.16.B.
  - 3. Remove all form release agents, curing compounds, hardeners, salts, efflorescence, laitance, loose material, unsound concrete, and other foreign materials by sandblasting, shot blasting, mechanical scarification, or other suitable methods.
  - 4. Dampen surface with clean water just prior to application of finishing compound.
  - 5. Mix 1 part bonding agent to 3 parts clean water for mixing liquid.
  - 6. Mix concrete finishing compound with mixing liquid as specified by the manufacturer.

7. Apply 2 coats using a stiff fiber brush or textured spray equipment. Spray application of the first coat requires back brushing to properly fill voids, bugholes and nonmoving cracks:
  - a. First coat: Apply at 2 pounds per square yard and allow to cure a minimum 24 hours.
  - b. Second coat: Apply at 2 pounds per square yard, allow to set and then float to a uniform finish.
8. Perform damp curing to applied product.

### 3.14 CURING

- A. Immediately after placement, damp cure all concrete for a minimum of 7 days. Add one day of cure for fly ash in excess of 25 percent or slag in excess of 15 percent of cementitious. Any time within this period that concrete temperature is less than 50 degrees Fahrenheit does not count.
- B. Cover all slabs and topping with approved burlap-polyethylene film and keep in place and moist throughout the curing period.
- C. Cover walls, beams, columns and other formed surfaces with burlap-polyethylene film or, where damp curing is not feasible due to location, and with written permission of SER, spray with an approved curing compound. In general, curing compound is not an acceptable substitute for damp curing.
- D. Anchor all burlap-polyethylene film at the edges to prevent moisture loss and removal by wind.
- E. Rewet all slab surfaces at least once a day during the curing period.
- F. Maintain a minimum 50 degrees Fahrenheit for entire damp cure period plus cool-down period, if applicable. See paragraph 3.10J.
- G. Curing compound may be applied to edge (vertical) surfaces of footings and base slabs upon stripping forms, if they are then immediately backfilled (buried) to top of member. Stripping, application, and backfilling shall be performed in the same day on any given area of concrete. Other surfaces shall receive damp cure except with written permission of SER.
- H. If curing compound is permitted to be applied, it shall be done in two applications made at right angles to one another, with no thin spots or holidays visible.

### 3.15 PATCHING

- A. Repair honeycomb and other defective areas, fill surface voids, and fill form tie holes and similar defects in accordance with ACI 301.
  1. Surface Preparation:
    - a. Expose, but not undercut or loosen, aggregate.
    - b. Expose all bugholes, cracks and subsurface voids.
    - c. Provide a clean, sound substrate with sufficient surface profile.
  2. Filling of deep voids, bugholes, etc., exceeding 1/8 inch depth:
    - a. Dampen surface with clean water to obtain saturated surface-dry (SSD) with no standing water.
    - b. Brush-apply a small quantity of mixed patching material as a scrub coat to prepare substrate. Thoroughly key-in and work material throughout cavity to promote bond:
      - 1) If scrub coat dries out before wet mortar can be placed, remove scrub coat similar to laitance removal.
    - c. Place repair mortar onto wet scrub coat using brush with firm trowel pressure:
      - 1) Completely fill voids.
      - 2) Key in and compact thoroughly to secure bond.
      - 3) Apply patching material in lifts of 1/4 inch (8mm) to 2 inches (51mm) and trowel to desired finish promptly after placing material.
    - d. For successive lifts, thoroughly score each lift and allow reaching initial set before next layer is applied.
    - e. Perform wet curing of patched areas for the following conditions:
      - 1) If temperature exceeds 85 degrees Fahrenheit (29 degrees Celsius).

- 2) If relative humidity is below 30 percent.
  - 3) If wind speed exceeds 15 miles per hour.
  - 4) If patches are exposed to direct sunlight for 72 hours after placement.
- B. Special curing compounds are allowed with approval of Owner and Engineer. Do not use solvent-based curing compound.
- C. Submit intended crack sealing material and procedure to Owner and Engineer for review. Inject or otherwise seal concrete cracks as observed during construction and leak testing operations with approved material to manufacturer's recommendations. Where exposed to view, remove excess material from surface of concrete in such a way as to minimize damage and visual disturbance to surface of concrete.
- D. Reinforce or replace deficient work as directed by Engineer and at no additional cost to Owner.

### **3.16 CLEAN UP AND DISPOSAL**

- A. Upon completion of the walls and prior to any painting, thoroughly clean all exposed or painted concrete surfaces of all concrete spatters, form oil, or other foreign material detrimental to appearance or painting.
- B. Remove all excess concrete debris remaining after completion of placement and form removal from the Site and dispose of in a proper and legal manner.

### **3.17 ANCHORING DOWELS**

- A. Drill hole in concrete to the size and depth and using type of bit as recommended by the adhesive supplier and as approved by Engineer.
- B. Clean hole with a nylon brush and use oil-free compressed air to blow out hole. Comply with adhesive manufacturer's recommendations. Note that most manufacturers require brushing and blowing twice.
- C. Fill hole with anchoring adhesive in accordance with manufacturer's recommendations. When finished, vertical dowels shall have adhesive level or slightly above surrounding surface such that water is not retained around dowel.

### **3.18 FIELD QUALITY CONTROL**

- A. Refer to section 01 45 10 for responsibilities, report frequency, and testing schedule. Refer to Structural Notes for further information.
- B. Refer to section 01 42 00 Watertightness Testing for leak testing requirements.
- C. Engineer may request adjustment to concrete mixes when characteristics of materials, job conditions, weather, test results, or other circumstances warrant.
- D. Periodically verify the use of specified mix design.
- E. Continuously inspect concrete and shotcrete placement for proper application techniques.
- F. Periodically inspect for maintenance of specified curing temperature and techniques.



**Table 2-1**

	<b>f'c @ 28 days</b>	<b>Maximum Water/Cement + Pozzolan Ratio</b>	<b>Maximum Pozzolan Content (percent of cement content)</b>	<b>Aggregate</b>	<b>Entrained Air Content (Refer to ACI 350, Severe Exp.)</b>	<b>Required Admixtures</b>
A. Concrete for walls, grade beams, slabs, beams, columns, base slabs, pads and all other concrete unless noted below	4,000 psi	0.45	30% Fly Ash 50% Slag 50% Combined	Section 2.01.C	ACI 350 - Table 4.2.1 (6% +/- 1.5%) No air entraining in interior concrete slabs or footings	None
B. Concrete exposed to de-icing chemicals	4,500 psi	0.42	ACI 350 - Table 4.2.3 30% Fly Ash 50% Slag 50% Combined	Section 2.01.C	ACI 350 - Table 4.2.1 (6% +/- 1.5%)	Corrosion Inhibitor
D. Concrete liquid-holding structures	4,000 psi	0.45	30% Fly Ash 50% Slag 50% combined	Section 2.01.C	ACI 350 - Table 4.2.1 (6% +/- 1.5%)	Crystalline Waterproofing
F. Grout for filling in bottom of liquid-holding structures *See Note 3	3,000 psi See note 2 below	0.48	30% Fly Ash 50% Slag 65% Combined	Section 2.01.C	ACI 350 - Table 4.2.1	Macro Fiber Reinforcement
G. Grout for filling CMU	3,000 psi	0.60	30% Fly Ash 50% Slag 50% Combined	Section 2.01.C	N/A	None

**Notes:**

- Concrete mixes shall be proportioned to achieve a maximum slump of 6 inches for concrete containing a mid-range water reducer, and 8 inches for concrete containing a high range water reducer. Concrete without water reducing admixtures shall have a slump of 4 inches +/-1 inch. This does not include concrete designed as self-consolidating. If mix designs are outside these ranges, report the design slump on the mix design and field tests should be within +/-1 inch of the design slump.
- Slump is used primarily as a measure of concrete consistency, truck to truck. If slump is outside these ranges, water content (water to cementitious ratio) shall be checked against allowable; and concrete rejected, accepted, or adjusted on that basis.
- Use Mix B (without corrosion inhibitor) where grout is subject to freeze-thaw (including but not limited to exterior channels where grout is intermittently exposed to cold air and backwash tanks).
- List of liquid-holding structures are provided in specification 01 42 00.
- See specification 04 20 00 Unit Masonry Assemblies for CMU grout.

**END OF SECTION**

## SECTION 03 36 50

### POLISHED CONCRETE FLOOR SYSTEM

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Polished concrete floor system.

##### 1.02 RELATED SECTIONS

- A. Section 03300 (03 30 00) – Cast-in-Place Concrete.

##### 1.03 DEFINITIONS

- A. IPCI – International Polished Concrete Institute is a resource for architects, designers and contractors to learn more about polished concrete. Contractors become certified through educating and testing on various labor driven techniques to perform a proper scope of work. They do not become certified to use certain products.
- B. Concrete Polishing – The process of utilizing industrial diamonds to grind and polish a concrete surface with the application of a impregnating hardeners and sealers that will densify, polish and seal the floor.
  - 1. Process may be either a proprietary system from specialty contractor or use of specified products with acceptable grinding methods.
  - 2. Acceptable Grinding Methods: Equipment and techniques that produce documented results of concrete finishes.

##### 1.04 REFERENCES

- A. ASTM C 1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
- B. ASTM D 523 – Standard Test Method for Specular Gloss.
- C. ASTM E 1155 – Standard Test Method for Determining  $F_F$  Floor Flatness and  $F_L$  Floor Levelness Numbers.

##### 1.05 SYSTEM DESCRIPTION

- A. Installation of polished concrete floor system for new interior concrete floors by dry grinding and polishing with various size grit metal-bonded and resin-bonded diamonds and application of concrete densifier.

##### 1.06 SUBMITTALS

- A. Comply with Section 01330 (01 33 00) – Submittal Procedures.
- B. Product Data: Submit installer's product data, including surface preparation and installation instructions.
- C. Installer's Certification: Submit IPCI certification of installer and installer's employees.

- D. Installer's Project References: Submit installer's list of successfully completed polished concrete floor system projects, including project name and location, name of architect, and type and quantity of polished concrete floor system installed.
- E. Maintenance Manual: Submit installer's maintenance manual, including maintenance and cleaning instructions for polished concrete floor system.

## **1.07 QUALITY ASSURANCE**

- A. Basis of Design: Perfect Polish, Mechanical Polishing, Ameripolish Dyes.
- B. Preinstallation Conference: Conduct conference at Project site before first concrete pour and start of application of Polished Concrete Floor Finish System. Require attendance of parties directly affecting work of this section, including Contractor, Architect, applicator, and Manufacturers representative.  
Review the following:
  - 1. Environmental requirements
  - 2. Curing methods
  - 3. Surface preparation.
  - 4. Application and decorative saw cuts.
  - 5. Repair.
  - 6. Field quality control.
  - 7. Cleaning.
  - 8. Protection of systems.
  - 9. Coordination with other work.
- C. Coordination: Concrete polisher shall coordinate the following:
  - 1. Concrete placement, floating, troweling and curing shall be coordinated with the polisher so surface is acceptable for polishing.
  - 2. Scheduling of joint sealant installation is not detrimental to the polishing process.
  - 3. Cleaning of concrete surface prior to performing polishing.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Provide polished concrete samples: size 4-inch by 4-inch or larger if specified for each polished concrete finish required.

## **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage:
  - 1. Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
  - 2. Keep materials from freezing.
- C. Handling: Protect materials during handling and application to prevent contamination or damage.

## **PART 2 PRODUCTS**

### **2.01 GRINDING AND POLISHING EQUIPMENT**

- A. Floor Grinder: Polishing shall be a dry diamond method, not wet, utilizing metal bonded diamond/resin bonded diamond multi orbital planetary action opposing rotational diamond headed machine with approximate grinding pressure of 675 pounds or more.
- B. Vacuum System: Vacuum system shall be directly connected to floor grinder to reduce amount of dust exposure. HEPA filtration system is required.

## 2.02 MATERIALS

- A. Concrete Densifier: Clear, odorless liquid form of a lithium silicate to permanently seal, densify, dustproof and harden concrete surfaces and provide abrasion resistance by penetrating into concrete pores and chemically reacting. Products must conform and meet minimum performance characteristics as described herein.
- B. Concrete Sealer: Clear, highly concentrated, quick drying penetrating water & oil repellent sealer specifically designed to deeply impregnate the surface pores and chemically bond with the concrete floor to increase durability.
- C. Penetrating Dye:
  - 1. Type: Solvent based.
  - 2. Color: [Black] [Burnt Orange] [Cactus Green] [Charcoal] [Dark Chocolate]
  - 3. [Deep Purple] [Fire Brick] [Golden Rod] [Gray] [Hunter Green] [Indian Red]
  - 4. [Mahogany] [Maroon] [Moss Green] [Pearl Blue] [Peru] [Rose] [Saddle Brown] [Steel Blue] [Teal] [Weathered Sand] [Wheat]. (Similar products/colorants may be substituted)

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine floor to receive polished concrete floor system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin surface preparation or installation until unacceptable conditions are corrected.
- D. Verify the Following for New Concrete Floors:
  - 1. Floor Finish:
    - a. Slabs and flatwork shall be placed and finished monolithically.
    - b. Strike off to true, plane surfaces at required elevations.
    - c. Thoroughly compact concrete with vibrators, floats, and tampers to force coarse aggregate below the surface.
    - d. Laser Screed floor when applicable.
    - e. Low speed power trowel with no hand finishing.
    - f. Pan float.
    - g. Steel trowel finish.
    - h. Surface should not be burned due to excessive troweling.
    - i. Imprints are not acceptable (i.e. boots, foreign objects dropped into concrete).
  - 2. Floor and Joints:
    - a. Free of debris and excessive dirt, dust, clay, and mud.
    - b. Dry.
  - 3. Floor Surface Profile:
    - a. Floor Flatness Number ( $F_f$ ): 50 (preferred) 45 (minimum).
  - 4. Concrete Compressive Strength: 3,500 psi to 5,000 psi.
  - 5. Lightweight Concrete: Not allowed if aggregate exposure is required.
  - 6. Concrete Curing: Minimum 8 days water cured or dissipating curing compound applied.
  - 7. Concrete Adjacent to Floor Penetrations: Troweled flat and level with surrounding concrete.
  - 8. Concrete Adjacent to Drains, clean-outs, etc: Finish level to the top of the structure.

### 3.02 SURFACE PREPARATION

- A. Protection: Protect surrounding areas and adjacent surfaces from the following:
  - 1. Minimal accumulation of dust from grinding and polishing.
  - 2. Contact with overspray of concrete densifier.

3. Contact with overspray of concrete sealer.
- B. Surface Preparation: Prepare surfaces in accordance with installer's instructions.
- C. Clean Surfaces: Remove dirt, dust, debris, oil, grease, curing agents, bond breakers, paint, coatings, and other surface contaminants which could adversely affect installation of polished concrete floor system.

### 3.03 INSTALLATION

- A. Install polished concrete floor system in accordance with installer's instructions at locations indicated on the Drawings.
- B. Aggregate Exposure:
1. Small Aggregate: Mottled salt-and-pepper coarse aggregate exposure.
  2. Large Aggregate: Mottled large coarse aggregate exposure.
- C. Polished Concrete Floor System: IPCI Sheen Level 2 – Honed Finish.
1. Preparation Step:
    - a. Remove existing floor coatings by grinding with 16-grit metal-bonded diamonds.
    - b. Remove existing floor coatings and level floor by grinding with 40-grit metal-bonded diamonds.
    - c. Open-up concrete to accept concrete densifier by grinding with 80-grit metal-bonded diamonds.
  2. Apply concrete densifier to deeply saturate floor.
  3. Remove residue of concrete densifier dried on floor surface by grinding with 150-grit metal-bonded diamonds.
  4. Floor Closure Polishing:
    - a. Remove 150-grit metal-bonded diamond scratches by grinding with 100-grit resin-bonded diamonds.
    - b. Remove 150-grit metal-bonded and 100-grit resin-bonded diamond scratches by grinding with 200-grit resin-bonded diamonds.
  5. Achieve low-sheen finish by grinding with 400-grit resin-bonded diamonds.
  6. Apply concrete sealer.
- D. Hand Tooling: When applicable in project utilize similar grinding and polishing process to blend the edges of all perimeter areas where obstructions lye with a variable speed polisher.

### 3.04 FIELD QUALITY CONTROL

- A. Inspect completed polished concrete floor system with Owner, Contractor, Architect, and Installer.
- B. Review procedures with Architect to correct unacceptable areas of completed polished concrete floor system.
- C. Testing: Test the following from completed polished concrete floor system:
1. Static Coefficient of Friction, ASTM C 1028:
    - a. Dry surface.
    - b. Wet surface.
  2. Specular Gloss/Reflectance, ASTM D 523:
  3. Floor Surface Profiles, ASTM E 1155:
  4. Compare test results from tests performed before and after installation of polished concrete floor system.

### 3.05 PROTECTION

- A. Protect completed polished concrete floor system from damage until Substantial Completion.
1. All hydraulic powered equipment shall be diapered to avoid staining of concrete.

2. Vehicle parking on polished concrete slab shall be prohibited. If necessary to complete their scope of work, drop clothes shall be placed under vehicles.
3. No pipe cutting machine shall be used on the finished floor slab.
4. Steel shall not be placed on the finish slab to avoid rusting.
5. Acids and acid detergents shall not be used nor come in contact with the slab.
6. All painters to use drop clothes on finished slab. If spilled, paint must be immediately removed.
7. All trades will be informed that the slab must be protected at all times.
8. Repair damaged areas of completed polished concrete floor system to satisfaction of the Architect.

**END OF SECTION**

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## SECTION 03 41 00

### PLANT-PRECAST STRUCTURAL CONCRETE

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide precast reinforced concrete units as follows:
  - 1. Deck panels.
    - a. Hollow-core slab units.
  - 2. Wall panels.
    - a. Insulated
    - b. Slab support corbels
    - c. Slab support ledge angles
  - 3. Accessories.
    - a. Grout.
    - b. Weld plates.
    - c. Shims.
    - d. Bearing pads.
    - e. Core end plugs.
    - f. Clips, hangers.
    - g. Joint sealant.
  
- B. Furnish the following for other sections to install, including, but not limited to:
  - 1. Structural precast accessories to be embedded in cast-in-place concrete:
    - a. Bearing plates.
    - b. Column anchor bolts.
  - 2. Structural precast accessories to be embedded in masonry:
    - a. Bearing plates.
  
- C. Install the following provided by others:
  - 1. Plant-precast architectural concrete: Spandrel wall panels.
  - 2. Sleeves and imbedded items for plumbing, heating, or electrical distribution.
  
- D. Perform the following:
  - 1. Provide openings as indicated on Drawings.
  
- E. Related Sections:
  - 1. Section 03 30 00 - Cast-in-Place Concrete
  - 2. Section 04 20 00 - Unit Masonry Assemblies
  - 3. Section 05 50 00 - Metal Fabrications
  - 4. Section 07 92 00 - Joint Sealants

##### 1.02 REFERENCES

- A. ACI:
  - 1. 301 - Specifications for Structural Concrete for Buildings
  - 2. 318 - Building Code Requirements for Reinforced Concrete
  
- B. ANSI/AWS:
  - 1. D1.1 - Structural Welding Code - Steel
  - 2. D1.4 - Structural Welding Code - Reinforcing Steel
  
- C. ASTM:
  - 1. A36 - Structural Steel
  - 2. A82 - Cold Drawn Steel Wire for Concrete Reinforcement



3. A123 - Hot Dip Galvanized Coatings on Steel Products
4. A153 - Zinc-Coating Iron and Steel Hardware
5. A185 - Wire Fabric for Concrete Reinforcement
6. A276 - Stainless Steel Bars and Shapes
7. A416 - Undercoat Seven-Wire Stress-Relieved Strand for Prestressed Concrete
8. A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
9. A666 - Cold-Worked Austenitic Stainless Steel Sheets, Plates, Strips
10. C33 - Concrete Aggregates
11. C144 - Aggregate for Masonry Mortar
12. C150 - Portland Cement
13. C260 - Air Entraining Admixtures for Concrete
14. C1107 - Packaged Dry Nonshrink Hydraulic Cement Grout
15. F593 - Stainless Steel Bolts, Hex Caps, Screws, Studs

D. CRSI - Manual of Standard Practice

E. PCI:

1. MNL 116 - Manual for Quality Control for Plants and Production of Precast Concrete Products
2. MNL 120 - Design Handbook-Precast and Prestressed Concrete
3. MNL 123 - Manual on Design of Connections for Precast Prestressed Concrete
4. MNL 124 - PCI Design for Fire Resistance of Precast Prestressed Concrete

### 1.03 SYSTEM DESCRIPTION

A. Critical Design Requirements for Architectural Precast Wall Panels:

1. Both wythes (interior and exterior) of insulated sandwich panels must be reinforced, either by prestressing or mild reinforcing.
2. Openings through panels larger than 8 inches must be plant-formed and cast.
3. Exposed panel faces, returns and edges must receive specified finish.
4. Controlled surface cracking - for faces and members exposed to weather - shall be limited to 0.007 inch.
5. Allowable tolerances: Panels must comply with the maximum allowable tolerances listed in the *Guide Specifications* of the Precast/Prestressed Concrete Institute (PCI), latest edition.
6. Design Deviations:
  - a. Permitted only after Engineer's written approval of manufacturer's proposed design supported by complete design calculations and drawings.
  - b. Design deviations shall provide an installation equivalent to the basic intent without incurring additional cost to Owner.

B. Performance Requirements for Wall Panels:

1. Size components to withstand design loads in an unrestrained condition according to State Building Code or as noted in the Structural drawings, whichever is greater.
2. Grout Keys: Capable of transmitting horizontal shear of 2,000 pounds per foot.
3. Insulation: Total minimum R-Value of 17.44.

C. Critical Design Requirements for Hollowcore Plank:

1. Openings through panels larger than 8 inches must be plant-formed and cast.
2. Exposed panel faces, returns and edges shall have clean flat finish with no obvious imperfections.
3. Controlled surface cracking on exposed faces shall be limited to 0.007 inch.
4. Allowable tolerances: Plank must comply with the maximum allowable tolerances listed in the *Guide Specifications* of the Precast/Prestressed Concrete Institute (PCI), latest edition.
5. Transmit lateral loads as necessary through top side of hollowcore plank to precast walls, not from bottom (interior, exposed) side.
6. Design Deviations:
  - a. Permitted only after Engineer's written approval of manufacturer's proposed design supported by complete, signed design calculations and drawings.
  - b. Design deviations shall provide an installation equivalent to the basic intent without incurring additional cost to Owner.

- D. Performance Requirements for Hollowcore Plank:
1. Size components to withstand design loads in an unrestrained condition according to State Building Code and loads enumerated in the Structural Notes or shown on the Drawings
  2. Grout Keys: Capable of transmitting a minimum horizontal shear of 2,000 pounds per foot or as noted in the Structural drawings, whichever is greater.
  3. Precast plank may be referred to as hollow on the plans and/or in the specifications, and yet they may be required to be a solid precast slab based on penetrations, suspended items, and loading. It is the responsibility of the precast supplier's engineer to determine if solid precast slabs are required. Solid slabs shall be provided at no additional cost. Notify Engineer of locations where solid slabs are required, for purposes of checking capacity of members below.

#### 1.04 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, concrete design mix, handling, storage and installation instructions, and maintenance and cleaning recommendations.
- C. Shop Drawings: Show complete information for fabrication and installation of precast concrete units, including:
1. Member dimensions, cross-section, location, size, type of reinforcement, including special reinforcement, and lifting devices necessary for handling and erection.
  2. Layout, dimensions, and identification of each unit corresponding to sequence and procedure of installation.
  3. Welded connections by AWS standard symbols.
  4. Detail inserts, connections, and joints; including accessories and construction at openings in precast units.
  5. Location, details of anchorage devices to be embedded in other construction. Furnish templates if required for accurate placement.
  6. Erection procedure for precast units and sequence of erection.
- D. Samples:
1. Selection Samples: Submit manufacturer's standard color and textures with Product Data and Shop Drawings.
  2. Color Verification: Prior to shipping, submit each type of finish indicated; in sets for each color, texture, and pattern specified, showing a full range of variations expected in these characteristics. Include notification to Engineer if selection is not within quoted price range.
  3. Components: Submit samples of anchors, fasteners, hardware, and other materials and components if requested by Engineer.
- E. Quality Assurance/Control Submittals:
1. Test Reports: Written report of proposed mix for each type of concrete and/or other materials at least 15 days prior to start of precast unit production if requested by Engineer.
  2. Certificates:
    - a. Certified design calculations: Prepared by structural engineer licensed in state where project is located.
    - b. Submit certificates of approval in compliance with Section 01 33 00 and Conform to IBC Chapter 17 - Special Inspections for Prefabricated Construction.
    - c. Provide AWS D1.1 certification for welders.
  3. Calculated fire-resistance analysis.
  4. Material Certificates:
    - a. Concrete materials.
    - b. Reinforcing materials and prestressing tendons.
    - c. Admixtures.
    - d. Bearing pads.
- F. Maintenance Manual: Provide to Owner, maintenance and warranty data in "Maintenance Manual" compliant with Section 01 78 23.

## 1.05 QUALITY ASSURANCE

- A. Qualifications of Personnel/Firm:
1. Design Calculations: Professional Structural Engineer licensed in the state where project is located.
  2. Fabricator: Firm with 5 years successful experience in fabrication of precast concrete units similar to units required for project; with sufficient production capacity to produce required units without delay in work; producer member of PCI and satisfactory participant in its Plant Certification Program.
    - a. Fabricators not meeting this requirement shall meet the requirements listed below:
      - 1) Employ an approved testing agency to inspect work requiring inspection when the assembly or fabrication is performed offsite. The testing agency shall furnish weekly inspection reports and a final report to the building official and the Architect and Engineer certifying the work was performed in accordance with the approved plans and specifications.
      - 2) Be pre-approved before bidding the Project. Submit qualifications, including a list of similar projects, description of facilities, personnel qualifications, and quality assurance plan and procedures to the Architect and Engineer a minimum of seven (7) days prior to Bid date.
      - 3) Prior to submittal of shop drawings, fabricators qualified under this paragraph shall provide, at their expense, a third-party external audit of their quality assurance plan showing that they maintain quality control procedures and perform inspections to ensure that their work is performed in accordance with contract documents and PCI standards and specifications. The third-party inspector shall be approved by the Architect and Engineer
    - b. Provide resume indicating compliance with work experience above. Work shall not begin until fabricator has submitted written documentation to Architect regarding work experience and PCI participation or documentation of alternative requirements listed above.
  3. Fabrication Plant: Plant engaged primarily in manufacturing of similar units.
  4. Supervision: 1 person present during execution of work, thoroughly trained with 5 years experience in materials and methods required, to direct fabrication and installation.
  5. Welder: Certified by AWS D1.1.
- B. Codes and Standards: Comply with referenced standards unless otherwise indicated.
- C. Fire-Resistance Rated Precast Units:
1. Comply with IBC code for state in which Project is located.
  2. Conform with PCI MNL-124 to achieve required ratings.
- D. Testing: Perform following ASTM tests for each 150 cubic yards of concrete placed, minimum of weekly, and provide documentation of compliance:
1. Slump: C143
  2. Compressive Strength: C31, C192, C39
  3. Air Content: C231 or C173
  4. Unit Weight: C138
- E. Field Samples: Furnish sample of each type of finish to Engineer for review prior to manufacture.
- F. Plant Review: If requested by Engineer, review precast products at plant prior to shipment to job site.
- G. Field-Erected Mockups:
1. Before installing structural precast concrete, erect mock-up for each form of construction and finish required to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution.
  2. Build mock-up to comply with the following requirements, using materials indicated for final unit of work.
    - a. Location: Locate mock-up on site in location and size indicated or, if not indicated, as directed by Engineer.

- b. Erect mock-up in presence of Engineer after having provided 7 days notification of date and time when mockup is to be constructed.
  - c. Scope: Demonstrate the proposed range of aesthetic effects and workmanship.
  - d. Acceptance: Obtain Engineer's acceptance of mock-up before start of final unit of work.
  - e. Maintenance: Retain and maintain mock-up during construction in undisturbed condition as a standard for judging completed unit of work.
3. Accepted mock-up in undisturbed condition at time of Substantial Completion may become part of completed unit of work.
- H. Preinstallation Meetings: Installer and manufacturer's technical representative shall meet with Engineer prior to the start of installation.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Protection: Comply with manufacturer's recommendations for job-site storage and protection.
- B. Deliver precast structural concrete units to Site in such quantities and at such times to ensure continuity of installation.
- C. Damaged Material: Replace damaged material prior to acceptance at no additional cost to Owner.
- D. Lift and support units only at designated lifting and supporting points as shown on Shop Drawings.
- E. Place stored units so that identification marks are discernible.
- F. Separate stacked members by battens across full width of each bearing point.
- G. Do not use upper member of stacked tier as storage area for shorter member or heavy equipment.
- H. Protect units from contact with soil or ground.

## **1.07 PROJECT CONDITIONS**

- A. Environmental Requirements: Heat surfaces to be grouted to above freezing prior to installation of grout; keep temperature above 40 degrees F for 48 hours after completion of grouting.
- B. Existing Conditions: Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## **1.08 SEQUENCING**

- A. Coordination with Other Trades: Coordinate with installation of other materials and erection of other structural systems, including items to be cast in pre-cast units.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Precast Concrete Units:
  - 1. Standard of Quality: Design is based on products of Wells Concrete Products Company, Wells, MN [www.wellsconcrete.com](http://www.wellsconcrete.com)
  - 2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Taracon Precast LLC
    - b. County Materials, Eau Claire, WI [www.countymaterials.com](http://www.countymaterials.com)
    - c. Gage Bros. Concrete [www.gagebrothers.com](http://www.gagebrothers.com)
    - d. Molin, Lino Lakes, MN [www.molin.com](http://www.molin.com)

- e. Huffcut Concrete, Inc. Chippewa Falls, WI <http://www.huffcutt.com>
  - f. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- B. Metallic Grout:
- 1. Acceptable manufacturers:
    - a. Embeco 885, Master Builders, Inc.
    - b. Ferrogrout, L & M Construction Chemicals. Inc.
    - c. Vibra-Foil, Grace Construction Products
    - d. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- C. Nonmetallic Grout:
- 1. Acceptable manufacturers:
    - a. Crystex, L & M Construction Chemicals, Inc.
    - b. Masterflow 928, Master Builders, Inc.
    - c. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Formwork:
- 1. General Requirements: Provide forms and form facing materials of metal, plastic, wood, other acceptable material, non-reactive with concrete, which produces required finish surfaces.
  - 2. Construction: Accurate, mortar-tight, of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and when prestressed, pretensioning and detensioning operations; completed units of shapes, lines, dimensions indicated, within fabrication tolerances specified in PCI MNL 116.
  - 3. Design: Unless forms for plant manufactured prestressed concrete units are stripped prior to detensioning, design so stresses are not induced in precast units due to deformation of concrete under prestress or to movement during detensioning.
- B. Reinforcing Materials:
- 1. Reinforcing Bars:
    - a. Deformed billet-steel: ASTM A615, Grade 60.
    - b. Deformed rail-steel: ASTM A616.
    - c. Deformed axle-steel: ASTM A617.
    - d. Deformed low-alloy steel: ASTM A706.
  - 2. Steel Wire: Plain, cold-drawn, ASTM A82.
  - 3. Wire Fabric:
    - a. Welded Steel: ASTM A185.
    - b. Welded Deformed Steel: ASTM A497.
  - 4. Supports for Reinforcement:
    - a. Bolsters, chairs, spacers, other devices for spacing, supporting, fastening reinforcing.
    - b. Comply with CRSI recommendations.
    - c. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, support with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).
  - 5. Dove Tail Slots: 22-gage galvanized steel slots 1-inch-wide by 1-inch-deep with 3/4-inch throat, plastic foam filled.
- C. Prestressing Tendons:
- 1. Uncoated, 7-wire stress-relieved strand complying with ASTM A416.
  - 2. Either Grade 250 or Grade 270.
  - 3. At manufacturer's option, similar strand, but with size and ultimate strength increased approximately 15 percent, or strand with increased strength but fewer number of wires.
- D. Concrete Materials:
- 1. Portland Cement: ASTM C150, Type I or Type III; one brand and type throughout unless otherwise acceptable to Engineer.
  - 2. Aggregates: ASTM C33, and as specified, from single source for exposed concrete.
  - 3. Lightweight Aggregate: ASTM C330.

4. Water: Drinkable, free from foreign materials in amounts harmful to concrete and embedded steel.
  5. Admixtures: Certified by manufacturer to be compatible with other required admixtures.
    - a. Air-entraining 6 percent, ASTM C260.
    - b. Water reducing, accelerating, high range water reducing admixtures: ASTM C494 Type A.
    - c. No other admixtures may be used without Engineer's acceptance.
    - d. Salts: The use of calcium chloride, chloride ions or other salts is not permitted.
- E. Supplementary Cementitious Materials:
1. Fly Ash: ASTM C618, Class C or F, with maximum loss on ignition of 3 percent.
  2. Metakaolin Admixture: ASTM C618, Class N.
  3. Silica Fume Admixture: ASTM C1240, with optional chemical and physical requirement.
  4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
- F. Connection Materials:
1. Steel Plates: Structural quality, hot-rolled carbon steel, ASTM A283, Grade C.
  2. Wide Flange Shapes: ASTM A992.
  3. Miscellaneous Steel Shapes: ASTM A36.
  4. Carbon-steel Headed Studs: ASTM A108, cold finished.
  5. Stainless Steel: ASTM A240, 302 or 304.
  6. Anchor Bolts: ASTM A307, low-carbon steel regular hexagon nuts, carbon steel washers.
  7. High Strength Threaded Fasteners: Heavy hexagon structural bolts, and hardened washers complying with ASTM A325.
  8. Finish of Steel Unit: Exposed units galvanized per ASTM A153; others painted with rust-inhibitive primer.
- G. Bearing Pads:
1. Elastomeric: Vulcanized, chloroprene elastomeric compound, molded to size or cut from molded sheet, 50 to 70 Shore A durometer.
  2. Laminated Fabric-rubber: Preformed, unused synthetic fibers, new, unvulcanized rubber, surface hardness 70 to 80 Shore A durometer.
  3. Random-oriented, Fiber-reinforced Elastomeric: Preformed, fibers set in elastomer, 70 to 90 Shore A durometer.
  4. Cotton-duck Fabric Reinforced Elastomeric: Preformed, horizontally layered fabric bonded to elastomer, 80 to 100 Shore A durometer.
  5. Frictionless: Tetrafluoroethylene (TFE), with glass fiber reinforcing as required for service load bearing stress.
  6. Tempered Hardboard: PS 58, smooth both sides.
  7. Plastic: Multimonomer plastic strips, non-leaching, no visible overall expansion under construction loads.
- H. Grout Materials:
1. Cement Grout: Portland cement, ASTM C150, Type I, and clean, natural sand, ASTM C144. Mix 1 part cement to 3 parts sand, by volume, with minimum water required for placement and hydration.
  2. Metallic Shrinkage-resistant Grout:
    - a. Premixed factory packaged ferrous aggregate grouting compound.
    - b. ASTM C1107, Grade B.
  3. Nonmetallic Shrinkage-resistant Grout:
    - a. Premixed, nonmetallic, noncorrosive, nonstaining product containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water reducing agents.
    - b. ASTM C1107, Grade B.
- I. Insulation Materials:
1. Extruded Polystyrene: R(minimum) = 5.40 per inch at 40 degrees F, 5.00 per inch at 75 degrees F (Aged Values).

## 2.03 PRECAST CONCRETE UNITS

- A. General Requirements:
  - 1. Free of voids or honeycomb, with straight true edges and surfaces.
  - 2. Texture:
    - a. Floor members: Broomed or raked top finish for bonding with concrete floor topping.
    - b. Roof members: Smooth, float top finish.
  - 3. Reinforcement: Adequate to resist transporting and handling stresses.
  - 4. Cast-in Weld Plates: Provide where required for anchorage or lateral bracing to structural steel and adjacent precast members, including cast-in weld plate to provide connection of flanges of adjoining members.
- B. Hollow Core Plank: Precast prestressed concrete units with open voids running full length of slabs.
  - 1. Provide headers of cast-in-place concrete or structural-steel shapes for openings larger than 1 slab width, according to hollow-core slab unit fabricator's written recommendations.
  - 2. Provide solid, monolithic precast slab units forming an integral part of hollow slab unit system. Design and fabricate to dimensions and details indicated for hollow slab units.
- C. Wall Panels:
  - 1. Panel Types: Insulated Flat Wall Panel.
  - 2. Plant fabricated, solid, precast prestressed concrete units produced under rigid factory-inspected process.
  - 3. 12 inches total thickness, full layer of insulation of thickness indicated, 3-inch minimum thickness face panel.
  - 4. Cast-in weld plates: Where required for anchorage or lateral bracing to structural steel and adjacent precast members, including weld plate to connect flanges of adjoining members.

## 2.04 ACCESSORIES

- A. Joint Sealant: As recommended by precast concrete manufacturer for interior and exterior locations, or if no recommendation by manufacture, use multi-component polyurethane sealant, including backing rod.
- B. Clips, hangers, other accessories required for installation and for support of subsequent construction or finishes.
- C. Other Materials: Materials not specifically described but required for complete, proper installation of structural precast concrete, subject to acceptance of Engineer.

## 2.05 MIXES

- A. General Requirements: Prepared by independent testing facility or by qualified precast manufacturing plant personnel, at precast manufacturer's option for each type of concrete required.
- B. Proportioning: By either laboratory trial batch or field experience methods, using materials to be employed for each type of concrete required. Comply with ACI 318.
- C. Compressive Strength: 5,000 psi minimum at 28 days.
- D. Release Strength for Prestressed Units: 3,500 psi minimum.
- E. Curing Compression Test Cylinders:
  - 1. Use same methods as for precast concrete work.
  - 2. Do not begin concrete production until Engineer reviews mixes and evaluations.

## 2.06 FABRICATION

- A. Comply with manufacturing and testing procedures, quality control recommendations, dimensional tolerances of PCI MNL-116, and as specified for types of units required.

- B. Built-in Anchorages:
  - 1. Accurately position and secure to formwork.
  - 2. Locate where they do not affect position of main reinforcement or placing of concrete.
  - 3. Do not relocate bearing plates in units unless acceptable to Engineer.
- C. Openings:
  - 1. Cast-in holes for openings larger than 8-inch diameter or 8-inch square in accordance with final Shop Drawings.
  - 2. Other smaller holes may be field cut by trades requiring them, as acceptable to Engineer.
- D. Form Preparation:
  - 1. Coat surfaces with bond-breaking compound before reinforcement is placed, with commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces requiring bond or adhesion.
  - 2. Comply with manufacturer's instructions.
- E. Installation of Reinforcement:
  - 1. Preparation: Clean off loose rust and mill scale, earth, other materials which reduce or destroy bond with concrete.
  - 2. Displacement: Accurately position, support, secure reinforcement against displacement by formwork, construction, or concrete placement operations.
  - 3. Support: Metal chairs, runners, bolsters, spacers, and hangers, as required.
  - 4. Place to obtain at least minimum coverages for concrete protection.
  - 5. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations.
  - 6. Wire Ties: Set so ends are directed into concrete, not toward exposed concrete surfaces.
  - 7. Cut ends of strands not enclosed or covered flush and cover with high strength mortar, bonded to unit with epoxy resin bonding agent.
- F. Pretensioning:
  - 1. Single strand tensioning method or multiple-strand tensioning method.
  - 2. Comply with PCI MNL-116 requirements.
- G. Concrete Placement:
  - 1. Continuous operation to prevent formation of seams or planes of weakness in precast units, complying with requirements of ACI 304.
  - 2. Thoroughly consolidate placed concrete by internal and external vibration without dislocation or damage to reinforcement and built-in items.
- H. Identification:
  - 1. Permanent markings to identify pick-up points and orientation in structure, complying with markings indicated on final Shop Drawings.
  - 2. Imprint date of casting on each precast unit on a surface which will not show in finished structure.
- I. Curing by Moisture Retention:
  - 1. Form cure minimum 20 hours by moisture retention (without heat) method or accelerated heat curing with low-pressure live steam or radiant heat and moisture.
  - 2. Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Take precautions to prevent moisture loss from concrete if using hot air for curing.
  - 3. Do not allow temperature of concrete to exceed 160 degrees F.
  - 4. Keep wet continuously for at least 6 days after being removed from the forms.
  - 5. Following curing period, allow the units to air dry for minimum 4 days before shipping to Site.
  - 6. Extend curing period if air temperature is below 50 degrees F.
- J. Detensioning:
  - 1. Timing: Delay until concrete has attained at least 70 percent of design stress, as established by test cylinders.



2. Heat-cured Concrete: Perform while concrete is still warm and moist, to avoid dimensional changes which may cause cracking or undesirable stresses in concrete.
3. Pretensioned Tendons: Gradual release of tensioning jacks or by heat cutting tendons, using sequence and pattern to prevent shock or unbalanced loading.

## 2.07 FINISHES

- A. Formed Surfaces: For formed surfaces of precast concrete as indicated for each type of unit, and as follows:
  1. Standard Finish:
    - a. Normal plant run finish produced in forms that impart smooth finish to concrete.
    - b. Small surface holes caused by air bubbles, normal form joint marks, minor chips and spalls will be tolerated, but no major or unsightly imperfections, honeycomb, or structural defects will be permitted.
  2. Commercial Finish:
    - a. Exposed-to-view precast-prestressed elements.
    - b. Remove fins, large protrusions and fill large holes.
    - c. Rub or grind ragged edges.
    - d. Faces to be true, well-defined surfaces.
- B. Unformed Surfaces:
  1. Apply trowel finish to unformed surfaces unless otherwise indicated.
  2. Consolidate concrete; bring to proper level with straightedge, float, and trowel to smooth uniform finish.
  3. Surfaces for Toppings: Apply scratch finish to precast units that will receive concrete topping after installation.
  4. Following initial strike off, transversely scarify surface to provide ridges approximately 1/4 inch deep.
- C. Exposed Textures: Fabricate precast units and provide exposed surface finishes as follows to match Engineer's control sample:
  1. Control Sample based on the products of Wells Concrete.
    - a. Sand: Genesee
    - b. Stone: Alabama Brown
    - c. Cement: Grey
    - d. Pigment: 1920 Rust Brown
    - e. Finish: Medium / Heavy Sandblast

## 2.08 SOURCE QUALITY CONTROL

- A. Fabrication Tolerances: Conform to referenced standards.
- B. Tests, Inspections:
  1. Testing: Unit dimensions smaller or greater than required, and outside specified tolerance limits are subject to additional testing as specified.
  2. Strength of Units: Strength of units will be considered potentially deficient if manufacturing processes fail to comply with any requirements which may affect strength, including following conditions:
    - a. Failure to meet compressive strength tests requirements.
    - b. Reinforcement, pretensioning and detensioning of tendons of prestressed concrete, not conforming to specified fabrication requirements.
    - c. Failure to cure, protect units against extremes in temperature as specified.
    - d. Precast units damaged during handling and erection.
  3. Suspected Non-compliance Testing: When there is evidence that strength of units does not meet specification requirements, the concrete testing service shall take cores drilled from hardened concrete for compressive strength determination, complying with ASTM C42 and as follows:
    - a. At least 3 representative cores from units of suspect strength, from locations directed by Engineer.

- b. Test cores in saturated surface dry condition per ACI 318 if concrete will be wet during use of completed structure.
  - c. Test cores in air-dry condition per ACI 318 if concrete will be dry during use of completed structure.
  - d. Strength of concrete for each series of cores will be considered satisfactory if average compressive strength is at least 85 percent of 28-day design compressive strength.
  - e. Test results are to be made in writing on same day tests are made, copies given to Engineer, Contractor, and precast manufacturer. Include project name, number, date, manufacturer's name, concrete testing service name, identification letter, name, type of member or members represented by core tests, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plan of concrete as placed, and moisture condition of core at time of bearing.
- 4. Patching: Where core test results are satisfactory and precast units are acceptable for use in work, fill core holes solid with patching mortar. Finish to match adjacent concrete surfaces.
  - 5. Defective Work: Replace with units that meet requirements of this section. Make corrections to other work affected by or resulting from corrections to precast concrete work at no cost to Owner.
- C. Verification of Performance:
- 1. Owner may employ separate testing laboratory to evaluate manufacturer's quality control and testing methods.
  - 2. Allow access to materials storage areas, concrete production equipment, concrete placement and curing facilities.
  - 3. Cooperate, provide samples of materials and concrete mixes as requested.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- B. Verification of Conditions: Verify that the structural precast concrete may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies:
  - 1. Immediately notify Engineer.
  - 2. Do not proceed with installation in areas of discrepancy until fully resolved.
  - 3. Commencement of installation signifies acceptance of surface conditions.

### **3.02 PREPARATION**

- A. Protection: Protect installed work and materials of other trades.
- B. Surface Preparation, Field Welding and Cutting: Protect units from damage, provide non-combustible shield as required.

### **3.03 ERECTION**

- A. Compliance: Comply with manufacturer's instructions, including product technical bulletin installation instructions and Shop Drawing details.
- B. Bearing Pads:
  - 1. Where indicated, as precast units are being erected.
  - 2. Set on level, uniform bearing surfaces.
  - 3. Maintain in correct position until precast units are placed.

- C. Powder-Actuated Fasteners: Do not use for surface attachment of accessory items in precast, prestressed unit unless otherwise accepted by precast manufacturer.
- D. Installation Tolerances: Do not exceed following tolerance limits:
  1. Variation from plumb: 1/4-inch in 20-foot run or story height, 1/2-inch total in 40-foot or longer run.
  2. Variation from level or elevations: 1/4-inch in 20-foot run; 1/2-inch in 40-foot run; total plus/minus 1/2 inch any location.
  3. Variation from position in plan: plus/minus 1/2-inch maximum any location.
  4. Offset in alignment of adjacent members any joint: 1/16-inch in 10-inch run: 1/4-inch maximum.
  5. The above tolerances do not include tolerances required for adhered membrane roofing; the most stringent controls. Installer shall make every effort to meet the roof manufacturer's warranty acceptance criteria by means of jacking or strand cutting, as deemed acceptable by the supplier's engineer. If field modifications to the precast roof panels are not sufficient to meet the roof manufacturer's warranty, a minimum 2-inch-thick bonded concrete topping slab (macro-fiber reinforced) shall be included at no additional cost.
- E. Grouting Connections and Joints: After precast concrete units placed and secured, grout open spaces at connection and joints.
  1. Retain grout in place until sufficiently hard to support itself.
  2. Pack spaces with stiff grout material; tamp until voids completely filled.
  3. Finish smooth, plumb, level with adjacent concrete surfaces.
  4. Keep grouted joints damp for not less than 24 hours after initial set.
  5. Promptly remove grout material from exposed surfaces before it hardens.
- F. Sealing Joints:
  1. Seal exposed and non-exposed, exterior and interior joints. Use primer and backer rod as recommended by sealant manufacturer.
  2. Seal joints between anywhere floor and walls join.

### **3.04 FIELD QUALITY CONTROL**

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.
- B. Field welds and connections using high-strength bolts will be subject to tests and inspections.
- C. Testing agency to report tests results promptly in writing to Contractor and Engineer.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

### **3.05 REPAIR/RESTORATION**

- A. Touch up marred finishes, but replace units that cannot be restored to factory-finished appearance. Use materials, procedures recommended or furnished by manufacturer.
- B. Damaged Metal Surface: Clean, apply coat of liquid galvanized repair compound to galvanized surfaces, compatible primer to painted surfaces.
- C. Units Having Dimensions Smaller or Greater Than Required and Outside Specified Tolerance Limits: If appearance or function of structure is adversely affected, or if larger dimensions interfere with other construction, repair, or remove and replace as required to meet construction conditions.

### **3.06 ADJACENT PANEL ALIGNMENT**

- A. Panels not in flush alignment with adjacent wall panels, and beyond allowable tolerance, must be replaced or, if possible, may be mechanically straightened and permanently fastened to remain at this intended alignment.

- B. Fastener hardware for such corrections must be concealed and cast into the original panels to allow for such correction. See Drawings.

### **3.07 CLEANING**

- A. Site:

1. Do not allow accumulation of scraps, debris arising from work of this section.
2. Maintain premises in neat, orderly condition.

- B. System:

1. Remove temporary covering and other provisions made to minimize soiling of other work.
2. Promptly clean, repair surfaces stained, marred or otherwise damaged during work.
3. Clean exposed surfaces of structural precast concrete using materials and methods recommended by manufacturer.
4. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.
5. When work is completed, remove unused materials, containers, equipment, and debris.

**END OF SECTION**

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## SECTION 04 20 00

### UNIT MASONRY ASSEMBLIES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Concrete masonry:
    - a. Concrete masonry units.
  - 2. Mortar and grout.
  - 3. Reinforcing steel.
  - 4. Joint reinforcement.
  - 5. Masonry accessories.
  
- B. Installation of material furnished by other sections, including, but not limited to:
  - 1. Loose steel lintels.
  - 2. Sleeves.
  - 3. Embedments.
  - 4. Hollow metal frames in masonry walls.
  
- C. Perform the following:
  - 1. Preparation of openings in masonry for recessed items.
  - 2. Modifications of existing masonry in areas of new construction.
  
- D. Related Sections:
  - 1. Section 03 30 00 - Cast-in-Place Concrete
  - 2. Section 03 41 00 - Plant-Precast Structural Concrete
  - 3. Section 05 12 00 - Structural Steel Framing
  - 4. Section 05 21 00 - Steel Joist Framing
  - 5. Section 05 40 00 - Cold-Formed Metal Framing
  - 6. Section 05 50 00 - Metal Fabrications
  - 7. Section 06 10 53 - Miscellaneous Rough Carpentry
  - 8. Section 07 84 00 - Firestopping
  - 9. Section 07 92 00 - Joint Sealants
  - 10. Section 08 11 13 - Hollow Metal Doors and Frames (Commercial)

##### 1.02 REFERENCES

- A. ACI:
  - 1. 315, SP66 - Details and Detailing of Concrete Reinforcement
  - 2. 530.1 - Specifications for Masonry Structures
  
- B. ASTM:
  - 1. A53 - Pipe, Steel, Hot-Dipped, Zinc Coated
  - 2. A153 - Zinc Coating, Hot Dip, on Iron and Steel Hardware
  - 3. A240 - Chromium and Chromium-Nickel Stainless Steel Plate
  - 4. A276 - Stainless Steel Bars and Shapes
  - 5. A307 - Carbon Steel Bolts and Studs.
  - 6. A479 - Stainless Steel Bars and Shapes for Use in Pressure Vessels (corrosive situations)
  - 7. A496 - Steel Wire, Deformed, for Concrete Reinforcement
  - 8. A580 - Stainless Steel Wire
  - 9. A615 - Deformed and Plain-Billet Steel Bars for Concrete Reinforcement
  - 10. A641 - Zinc Coated Galvanized Carbon Steel Wire
  - 11. A666 - Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar For Structural Applications
  - 12. A775 - Epoxy Coated Steel Reinforcing Bars

13. A951 - Masonry Joint Reinforcement
14. B370 - Copper Sheet
15. B633 - Electrodeposited Zinc on Iron or Steel
16. C40 - Test for Organic Impurities in Fine Aggregates for Concrete
17. C67 - Test for Sampling and Testing Brick and Structural Clay Tile
18. C90 - Load Bearing CMU
19. C91 - Masonry Cement
20. C126 - Ceramic Glazed Brick and Tile
21. C129 - Non-Loadbearing Concrete Masonry
22. C140 - Concrete Masonry Units Testing
23. C144 - Aggregates for Masonry Mortar
24. C207 - Hydrated Lime for Masonry Purposes
25. C216 - Facing Brick
26. C270 - Mortar for Unit Masonry
27. C315 - Clay Flue Linings
28. C395 - Chemical Resistant Resin Mortars
29. C404 - Aggregates for Masonry Grout
30. C476 - Grout for Masonry
31. C494 - Chemical Admixtures for Concrete
32. C150 - Portland Cement
33. C578 - Rigid Cellular Polystyrene Thermal Insulation
34. C780 - Mortar Mixes
35. C1019 - Grout Sampling and Testing
36. C1093 - Testing Agency Qualifications
37. C1142 - Ready-Mixed Mortar for Unit Masonry
38. C1314 - Prism Compressive Strength
39. C1329 - Mortar Cement
40. D226 - Asphalt Saturated Organic Felt for Roofing and Waterproofing
41. D1056 - Flexible Cellular Materials
42. D3278 - Flash Point of Liquids
43. E96 - Water Vapor Transmission
44. E119 - Fire Tests of Building Construction and Methods
45. E488 - Strength of Concrete and Masonry Anchors
46. E514 - Water Penetration and Leakage Through Masonry
47. F593 - Stainless Steel Bolts, Screws, Studs
48. F594 - Stainless Steel Nuts
49. F738 - Stainless Steel Metric Bolts, Screws, Studs
50. F836 - Stainless Steel Metric Nuts, Style 1

C. AWS D1.4 - Structural Welding Code - Reinforced Steel

D. IBC Code: Currently in effect and adopted by state in which Project is located.

### 1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Provide unit masonry that develops the following installed compressive strengths ( $f'_m$ ) at 28 days:
  - a. For Concrete Unit Masonry: Based on net area:  $f'_m = 1900$  PSI (13.1 MPa).
2. Provide unit masonry that meets or exceeds fire resistance requirements.

### 1.04 SUBMITTALS

A. Refer to Section 01 33 00.

B. Product Data:

1. For each product indicated. Include size variation data verifying that actual range of sizes for brick falls within ASTM C216 dimension tolerances.
2. Mix designs for each type of mortar and grout, including description of type and proportions of ingredients.

- C. Shop Drawings:
  - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
  - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315.
  - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
  - 4. Include the full range of exposed color and texture expected in complete work.
- D. Quality Assurance/Control Submittals:
  - 1. Qualification Data:
    - a. Manufacturers, Contractor: Include lists of completed, similar sized projects with project names and addresses, names and addresses of Engineers and Owners, and other information specified.
    - b. Testing agency: ASTM C1093.
  - 2. Cold-weather Procedures: Describe methods, materials and equipment to be used to comply with cold-weather requirements, if applicable.
  - 3. Material certificates and test reports.

## 1.05 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide materials made of components, with uniform texture and color or blend, furnished by one manufacturer for each type of masonry, mortar, aggregate and accessory.
- B. Qualifications:
  - 1. Manufacturer: 5 years' experience in the manufacture of unit masonry.
  - 2. Contractor: 3 years' experience in the installation of unit masonry.
  - 3. Personnel:
    - a. Foreman: Competent, in charge of Work at all times, for duration of Work unless otherwise permitted by Engineer.
    - b. Installer of masonry units: Skilled journeyman masons.
    - c. Mixer personnel: Thoroughly trained, with at least 1 person with 1 year experience (minimum) mixing mortar.
- C. Regulatory Requirements: Comply with pertinent requirements of governing authorities and referenced portions of ACI, NCMA and BIA industry standards.
- D. Certificate for Fire Performance and Characteristics: Certify materials and construction are in compliance with ASTM E119, by recognized testing and inspecting organization, or by other means, acceptable to authority having jurisdiction.
- E. Material Certificates and Test Reports: Provide statements and tests of material properties indicating compliance with standards for each type and size of the following:
  - 1. Masonry Units:
    - a. Material test reports and statement of compressive strength.
    - b. Bricks, including size-variation data.
    - c. Exposed brick, including test report for efflorescence according to ASTM C67.
    - d. Surface-coated brick, including test report for durability of surface appearance after 50 cycles of freezing and thawing per ASTM C67.
    - e. Concrete masonry units: ASTM C140.
    - f. Structural masonry units, including data and calculations establishing average net-area compressive strength of units.
  - 2. Prism: ASTM C1314.
    - a. Prisms shall consist of concrete block assembly such that 2 grouted face shell levels are in compressed zone and laid in stack bond.
    - b. Prior to construction: Construct and test 5 ungrouted concrete block prisms.
    - c. During construction: Construct and test 3 ungrouted concrete block prisms.
    - d. 28 days after construction:
      - 1) Test in accordance with ASTM E447. The acceptable test result shall be the average of each set of prisms.



- 2) Masonry prism compressive strength: 2500 psi.
3. Cementitious materials.
4. Mortar: ASTM C780.
5. Preblended, dry mortar mixes.
6. Grout mixes: ASTM C1019.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

## 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection:
  1. Assume responsibility for acceptance of masonry units delivered to site being in compliance with specified ASTM requirements for chippage and dimensional tolerances.
  2. Comply with manufacturer's recommendations for job-site storage and protection.
  3. Unit Masonry: Store off ground and protected from wetting or contaminants likely to cause staining or defects in the masonry.
  4. Cementitious Materials: Store off ground, under cover, in dry location.
  5. Aggregates: Store to maintain grading, other required characteristics, and avoid contamination.
  6. Preblended, Dry Mortar Mix: Deliver in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store on elevated platforms, under cover, and in dry location or metal dispensing silo with weatherproof cover.
  7. Masonry Accessories Including Metal Items: Store to prevent corrosion and accumulation of dirt and oil.

## 1.07 PROJECT CONDITIONS

- A. Existing Conditions: Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## 1.08 MAINTENANCE

- A. Extra Materials:
  1. Provide for maintenance purposes, quantity unit masonry equal to 2 percent of each type of material installed.
  2. Package and mark to identify building and material type and color.
  3. Store as directed after completion of Work.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. Concrete Masonry Units:
  1. Standard of Quality: Design is based on products of County Materials, [www.countymaterials.com](http://www.countymaterials.com)
  2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Amcon Block and Precast Company, St. Cloud, MN [www.amconblock.com](http://www.amconblock.com)
    - b. Arlington Concrete Products Inc., Arlington, MN
    - c. County Materials, Marathon WI [www.countymaterials.com](http://www.countymaterials.com)
    - d. W.W. Thompson Concrete Products, Brainerd, MN
    - e. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- B. Mortar and Grout Materials:
  1. Portland Cement, Mortar Cement, Masonry Cement, and Lime: Acceptable manufacturers, subject to compliance with requirements, are:
    - a. Lafarge Corporation, Dallas, TX [www.lafargenorthamerica.com](http://www.lafargenorthamerica.com)
    - b. Lehigh Cement Company, Allentown, PA [www.lehighwhitecement.com](http://www.lehighwhitecement.com)

- c. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
  - 2. Water Repellent Admixture: Acceptable manufactures, subject to compliance with requirements are:
    - a. DryBlock by Grace Construction Products, Cambridge, MA [www.DryBlock.com](http://www.DryBlock.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
  - 3. Premixed Mortar: Acceptable manufacturers, subject to compliance with requirements, are:
    - a. Spec Mix [www.specmix.com](http://www.specmix.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
  - 4. Epoxy Pointing Mortar (Joint Grout): Acceptable manufacturers, subject to compliance with requirements, are:
    - a. Summitville Tiles Inc., Summitville, OH [www.summitville.com](http://www.summitville.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- C. Joint Reinforcement:
- 1. Standard of Quality: Design is based on products of Heckmann Building Products, Inc., Chicago, IL [www.heckmannbuildingprods.com](http://www.heckmannbuildingprods.com)
  - 2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Dur-O-Wal Inc., Aurora, IL [www.dur-o-wal.com/](http://www.dur-o-wal.com/)
    - b. Hohmann & Barnard, Hauppauge, NY [www.h-b.com](http://www.h-b.com)
    - c. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Portland Cement: ASTM C150, Type I.
- B. Lime: ASTM C207, Type S.
- C. Mortar Cement: ASTM C1329. Contractor has option of using pre-mixed mortar indicated below.
  - 1. Comply with ASTM C270 for types of mortar indicated below.
    - a. At or below grade: Type S.
    - b. Above grade: Type N, except as noted.
    - c. Above grade: Modified Type N.
  - 2. Reinforced Masonry: Type S
- D. Pre-Mixed Mortar:
  - 1. Meet ASTM C1142.
  - 2. Preblended, dry mortar mix
  - 3. Measure by weight to ensure accurate proportions.
  - 4. Thoroughly blend ingredients before delivering to Site.
- E. Epoxy Pointing Mortar (Joint Grout):
  - 1. Meet ASTM C395, epoxy-resin-based material formulated for use as pointing mortar.
  - 2. Product: *S-400*.
  - 3. Mix to comply with mortar manufacturer's written instructions.
  - 4. Color: As selected by E/A from manufacturer's standard colors.
- F. Grout Design Mix:
  - 1. ASTM C476.
  - 2. Minimum Compressive Strength: 3000 psi at 28 days.
  - 3. Mix Proportion: 1-part portland cement, 2-1/2 parts sand, 1-1/2 parts pea gravel, and adequate water to produce a concrete of approximate 10-inch slump.
- G. Masonry Cement: ASTM C91.
- H. Aggregate:
  - 1. Mortar: ASTM C144, natural or manufactured sand.
  - 2. Grout: ASTM C404, natural or manufactured sand, gravel, crushed stone, or slag.

- I. Water: Clean and free of oils, acids, alkalis, salts, organic materials, or other substances in amounts that may be harmful to mortar, grout, or embedded metals.
- J. Admixtures:
  - 1. Do not use air-entraining admixtures or materials containing air-entraining admixtures.
  - 2. Do not add set-retarding or set-accelerating, bond modifying, or corrosion-inhibiting admixtures to mortar or grout without written approval of Engineer.
  - 3. Do not use chloride or products containing chloride in mortar or grout in which metal reinforcement or accessories will be embedded.
  - 4. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
  - 5. Water-Repellent Admixture: Intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

### 2.03 MANUFACTURED UNITS

- A. Concrete Masonry Unit:
  - 1. Provide architectural CMU with integral water repellent admixtures.
  - 2. Modular, hollow and solid load-bearing standard weight.
  - 3. Conforming to ASTM Standard C90, Type I, Grade N.
  - 4. Corner blocks, jamb units, bond beam units, and special sizes and shapes as indicated or otherwise required.
  - 5. Defects:
    - a. Exposed common CMU: Limited to 1/2-inch diameter defect in no more than 5 percent of the block. 2 defects maximum per block.
    - b. Burnished CMU: Limited to 3/8-inch-diameter in no more than 5 percent of Block. One defect maximum per block.
  - 6. Block Types (normal weight unless otherwise specified):
    - a. Block Type "A":
      - 1) Nominal block size: 8 inch by 16-inch face.
      - 2) Face style: Common.
      - 3) Block color: Natural gray.

### 2.04 REINFORCEMENT

- A. Reinforcing Steel:
  - 1. Reinforcing Bars:
    - a. Uncoated deformed steel, ASTM A615, Grade 60.
    - b. Epoxy coated deformed steel, ASTM A615, ASTM A775, Grade 60.
- B. Joint Reinforcement:
  - 1. Meet ASTM A951.
  - 2. Prefabricated welded-wire units with deformed continuous side rods and plain cross rods, straight lengths of not less than 10 feet-0 inches, with prefabricated corner and tee units.
  - 3. Width: Approximately 2 inches less than nominal width of walls and partitions.
  - 4. Mortar coverage: Minimum 5/8-inch on joint faces exposed to exterior and 1/2-inch elsewhere.
  - 5. Steel Wire Size:
    - a. Standard: 9 gage side and cross rods.
- C. Finishes:
  - 1. Extreme Corrosive Situations: ASTM A479, 304, Annealed and ground, stainless steel.
- D. Design:
  - 1. Single-Wythe Masonry: Truss or ladder type with single pair of side rods and continuous diagonal cross rods spaced not more than 16 inches on center.
- E. Anchor Bolts:
  - 1. Steel bolts with hex nuts and flat washers.

2. Carbon: ASTM A307, Grade A
  - a. Hot-dip galvanized, Class C.
  - b. In sizes and configurations indicated.
  
- F. Shelf Angle Anchors: Unit type masonry inserts in concrete: cast iron or malleable iron inserts of type and size indicated.
  
- G. Post-installed Anchors: Chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in concrete, per ASTM E488 testing by qualified testing agency:
  1. Corrosion Protection:
    - a. Carbon-steel components zinc-plated to comply with ASTM B633, Class Fe/Zn 5 for Class SC 1 service condition (mild).
    - b. Stainless-steel components complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.
      - 1) Bolts and nuts ASTM F738 and ASTM F836.
      - 2) Anchors: ASTM A666 or ASTM A276 304 or 316.

## 2.05 INSULATION

- A. Rigid Foundation Insulation (extruded polystyrene):
  1. Rigid, cellular thermal insulation with closed-cells and integral high-density skin, formed by expansion of polystyrene base resin in extrusion process complying with ASTM C578, Type IV.
  2. Thermal Value: 5-year aged R-values of 5.4 and 5 at 40- and 75-degrees F respectively.
  3. Density: 1.6 pounds per cubic foot minimum density, unless otherwise indicated.
  4. Compressive Strength (foundation insulation): 25 pounds per square inch.
  5. Preformed Units: To fit applications indicated, selected from manufacturer's standard thicknesses, widths, lengths.
  6. Thickness: As indicated on Drawings.
  7. Adhesive: Include manufacturer's recommended adhesive or other fasteners to make positive attachment to inner wythe or concrete masonry unit.

## 2.06 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler, Non-metallic Expansion Joint Strips:
  1. Premolded, flexible cellular neoprene rubber filler strips.
  2. ASTM D1056, Grade 2A1.
  3. Capable of compression up to 35 percent of width and thickness indicated.
  
- B. Pipe Sleeves: 3-inch diameter Schedule 40, ASTM A53, 14 inches long, at locations above ceiling as directed by Engineer. Provide and install as needed.
  
- C. Pressure Treated Wood Blocking: See Section 06 10 53.
  
- D. Isolation Sheet: 4 mil polyethylene; use to separate incompatible metals from direct contact.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Work of Other Trades: Prior to commencing Work, carefully inspect, with installer present, and verify that Work is complete to point where this installation may properly commence. Examine surfaces that will support masonry work to ensure completion to proper lines and grades.
  
- B. Verification of Conditions: Verify that unit masonry systems may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
  
- C. Discrepancies:
  1. Immediately notify Engineer/Architect.

2. Do not proceed with installation in areas of discrepancy until fully resolved.
3. Commencement of installation signifies acceptance of surface conditions.

### 3.02 PREPARATION

- A. Protection of Work:
1. During erection, cover top of walls with waterproof sheeting at end of each day's work. Cover partially completed structures when Work is not in progress. Extend cover minimum 24 inches down both sides and hold securely in place.
  2. Masonry to be exposed or painted: Prevent grout, mortar or soil from staining face. Immediately remove grout or mortar in contact with such masonry.
  3. Base of walls: Protect from rain-splashed mud, mortar splatter by spreading coverings on ground and over wall surface.
  4. Sills, ledges, projections: Protect from droppings of mortar.
- B. Cleaning Reinforcing: Before placing, remove loose rust, ice, other coatings from reinforcing.

### 3.03 INSTALLATION, GENERAL

- A. Procedures:
1. Single-wythe walls: Build to actual thickness of masonry units, using units of nominal thickness indicated.
  2. Chases and recesses: Build as shown or required for Work of other trades, with at least 8 inches of masonry between chase or recess and jamb of openings, between adjacent chases, recesses.
  3. Use bullnose masonry at corners and jambs, unless detailed otherwise.
  4. Leave openings for equipment to be installed before completion of masonry Work.
  5. After installation of equipment, complete masonry Work to match Work immediately adjacent to opening.
- B. Cutting:
1. Use motor-driven saws to provide clean, sharp, unchipped edges.
  2. Cut to provide continuous pattern and to fit adjoining Work.
  3. Use full-size units without cutting where possible.
  4. Use dry cutting saws to cut concrete masonry units.

### 3.04 LAYING MASONRY UNITS

- A. General:
1. Do not install masonry units that are cracked, broken, or chipped in excess of ASTM allowances.
  2. When possible, orient units so that small chips and cracks are not on exposed side of wall.
  3. Align unit cells or cores that are to be grouted.
  4. Place units in final position while mortar is soft and plastic.
  5. Match approved mock-up panel to provide uniform color blending in walls of exposed brick or CMU and to avoid patchy effect.
- B. Layout and Tolerances:
1. Layout in advance for accurate spacing of surface bond patterns with uniform joint widths, accurate location of openings, movement-type joints, returns, and offsets.
  2. Avoid use of less- than-half-size units at corners, jambs, and wherever possible at other locations.
  3. Comply with specified construction tolerances, with courses accurately spaced and coordinated with other Work.
  4. Install masonry to distance from adjoining dissimilar materials as detailed or if not detailed, 3/4-inch maximum.
- C. Pattern Bond:
1. Match patterns as indicated. If not shown, lay in running bond with vertical joint in each course centered on units in courses above and below.

2. Concealed masonry: Lay with units in wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners.
  3. Do not use units with less than nominal 4-inch horizontal face dimensions at corners, jambs.
- D. Stopping and Resuming Work:
1. Rake back 1/2-unit length in each course; do not tooth.
  2. Clean exposed surfaces of set masonry, wet units lightly (if required), remove loose masonry units and mortar prior to laying fresh masonry.
- E. Built-in Work:
1. As Work progresses, build-in items specified under this and other sections of these specifications.
  2. Coordinate with any other trades involved.
  3. Install all metal frames, bolts, inserts, sleeves, bearing plates, and other items required to be set in masonry.
  4. Fill all hollow metal frames with concrete unless indicated otherwise. Rake out joint between frame and concrete masonry unit to create 3/8-inch reveal.
  5. Fill in solidly with masonry around built-in items.
  6. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
  7. Built-in items to be embedded in cores of hollow masonry units: Place layer of metal lath in joint below, rod mortar or grout into core.
  8. Embed anchors and ties at least 1/2 inch in mortar of outer face shell of hollow units and 1-1/2 inches in mortar of solid masonry.
  9. Hollow concrete masonry units: Fill cores with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
  10. Do not disturb or bend ties or anchors after embedding in grout or mortar.

### 3.05 BEDDING AND JOINTING

- A. Mortar Mixing:
1. Mix mortar in accordance with the requirements of ASTM C270.
  2. Control batching procedure to ensure proper proportions by measuring materials by volume or weight as specified.
  3. Control amount of mixing water and mortar consistency.
  4. Discard mortar or grout that has partially set or is not used within 1-1/2 hours of mixing.
  5. Re-temper with 1-1/2 hours of mixing to replace moisture lost by evaporation. Do not retemper colored mortars.
- B. Solid Brick Masonry Units:
1. Lay with completely filled bed and head joint.
  2. Butter ends with sufficient mortar to fill head joints, shove into place.
  3. Do not slush head joints.
  4. Back bevel bed joints to minimize mortar droppings in cavity.
- C. Hollow Concrete Masonry Units:
1. Lay full mortar coverage on horizontal and vertical face shells.
  2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
  3. For starting course on footings where cells are grouted, spread out full mortar bed including areas under cells.
- D. Joints:
1. Joint widths: Maintain as shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 3/8-inch joints.
  2. Masonry walls to be concealed or covered by other materials: Cut flush unless otherwise indicated.
  3. Exposed joints: Tool brick or concrete masonry joint slightly concave using jointer larger than joint thickness, unless otherwise indicated.
  4. Burnished concrete masonry, other masonry with scored faces: Rake interior joints 3/8-inch deep.

5. Concrete masonry with scored faces: Fill scores with mortar; tool to match joints.
  6. Glazed masonry units: Use a nonmetallic jointer 3/4 inch or more in width.
- E. Masonry Units Disturbed After Laying:
1. Clean, reset in fresh mortar.
  2. Do not pound corners of jambs to shift adjacent stretcher units that have been set in position.
  3. If adjustment required, remove units, clean off mortar, reset in fresh mortar.
- F. Epoxy Mortar (Grout):
1. Substrate: Cured masonry surfaces.
  2. Fill bond beams, block cores, voids with specified grout indicated on Drawings, where specified, or where otherwise required by construction.
  3. Installation:
    - a. Rake back cement mortar 3/8-inch (minimum) while still toolable.
    - b. Force as much epoxy mortar into joint as possible.
    - c. Tool prior to mortar losing plasticity.
  4. Keep grout cores clean. When grout pour exceeds 5 feet, provide cleanout holes in bottom course of masonry for each core, as required for inspection and cleaning. Replace cleanout plugs only after area to be grouted has been accepted.
  5. Notify E/A when grout elements are ready for inspection.
  6. Use grout within 1-1/2 hours of mixing.
  7. Clean Up: Use "Scotch-Brite" pad and minimum amount of water, clean completely.
- G. Sand:
1. Concrete masonry units: Fill cores, voids with mason sand.
  2. Sound absorption block: Fill non-fibrous cores with sand.
  3. Seal around electrical devices, other built in items; fill cores in two-course lifts, rodding or vibrating to ensure filling of all voids and spaces.

### **3.06 NON-BEARING INTERIOR PARTITIONS**

- A. Height: Build to underside of solid floor or roof structure above, unless otherwise shown.
- B. Install with steel angles leaving a gap between top of wall and deck.
- C. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
- D. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 00.

### **3.07 REINFORCED MASONRY**

- A. Set reinforcing bars in grout; do not use mortar.
- B. Schedule:
  1. Bond beams.
  2. Vertical cores at each side of lintels.
  3. Vertical reinforcing for walls.
  4. Mitered concrete masonry unit corners, every other course.
  5. Vertical reinforcing in parapets as indicated on Drawings, or if not indicated, 2 feet-8 inches on center.

### **3.08 HORIZONTAL JOINT REINFORCEMENT**

- A. Continuous Horizontal Joint Reinforcement as Indicated:
  1. Longitudinal side rods in mortar for entire length with minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere.
  2. Lap reinforcing minimum 6 inches.

3. Cut or interrupt at control and expansion joints, unless otherwise indicated.
  4. Reinforce walls with continuous horizontal joint reinforcing unless specifically noted to be omitted.
  5. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections.
  6. Cut, bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, other special conditions.
  7. Space continuous horizontal reinforcement as follows:
    - a. Multi-wythe walls where continuous horizontal reinforcement acts as structural bond or tie between wythes: As required by code but not more than 16 inches on center vertically.
    - b. Single-wythe walls: 16 inches on center vertically, unless otherwise indicated.
  8. Parapets: 8 inches on center vertically, unless otherwise indicated.
- B. Reinforcement at Openings:
1. Reinforce masonry openings greater than 1-foot wide with horizontal joint reinforcement placed in 2 joints approximately 8 inches apart, immediately above lintel and immediately below sill.
  2. Extend minimum 2 feet beyond jambs of opening except at control joints.

### 3.09 CONTROL AND EXPANSION JOINTS

- A. Vertical and horizontal expansion, control, isolation joints in masonry where shown must be unobstructed by structure, mortar, or reinforcing. Build-in related items as masonry Work progresses:
1. Build flanges of metal expansion strips into masonry.
  2. Lap each joint 4 inches in direction of water flow.
  3. Seal joints below grade and at junctures with horizontal expansion joints, if any.
  4. Build flanges of factory-fabricated expansion joint units into masonry.
  5. Build in non-metallic fillers where indicated.
  6. Build in horizontal pressure relieving joints where indicated; construct joints by either leaving an air space or inserting non-metallic compressible joint filler of width required to permit installation of sealant and backer rod.
  7. Locate horizontal pressure relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.
  8. Space joints as indicated on Drawings, or if not indicated 24 feet (maximum) on center. Verify location in writing with Engineer.
  9. Offset control joints in wythes of dissimilar materials.

### 3.10 ANCHORING MASONRY WORK

- A. Anchor devices of type indicated to structural members where masonry abuts or faces structural members, to comply with following:
1. Open space not less than 1 inch width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.
  2. Flexible anchors embedded in masonry joints and attached to structure.
  3. Dovetail anchors at precast concrete panels that will hold brick veneer rigidly in place and transfer wind loading back to panels.
  4. Space as indicated, but not more than 16 inches on center vertically, 16 inches on center horizontally.

### 3.11 LINTELS

- A. Steel Lintels: Install where indicated.
- B. Masonry Lintels:
1. Prefabricated or built-in-place from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout.
  2. Where shown and wherever openings of more than 12 inches for brick size units and 24 inches for block size units are shown without structural steel or other supporting lintels.
  3. Cure before handling and installing.
  4. Temporarily support built-in-place lintels until cured.



- C. Hollow Concrete Masonry Unit Walls:
  - 1. Specially formed U-shaped lintel units, reinforcement bars placed as shown, filled with concrete.
  - 2. Match CMU in color, texture, and compressive strength.
  - 3. Where no reinforcement is shown, two Number 5 bars minimum.
  - 4. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

### 3.12 ADJUSTING

- A. Remove damaged masonry units and units that do not match adjoining units as intended. Replace with new units to match adjoining units; install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes, except weep holes, and completely fill with mortar. Point-up joints including corners, openings, and adjacent Work to provide a neat, uniform appearance, prepared for application of sealants. Tuck point and repair cracks or nail holes 1/32 of an inch or larger.
- C. Shoring and Bracing: Provide temporary support for masonry elements such as lintels, beams, arches, and soffits. Do not remove until masonry has cured sufficiently to carry its own weight and other temporary loads that may be placed on it during construction.

### 3.13 FIELD QUALITY CONTROL

- A. Site Tests: Comply with requirements of Section 01 45 10.
- B. Construction Tolerances:
  - 1. Variation from plumb: Do not exceed 1/4 inch in 10 feet, or 3/8 inch in a story height not to exceed 20 feet, or 1/2 inch maximum.
  - 2. Variation from level:
    - a. Bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, other conspicuous lines: Do not exceed 1/4 inch in 10 feet or 1/2 inch maximum.
    - b. Top surface of bearing walls: Do not exceed 1/4 inch in 10 feet or 1/2 inch maximum.
  - 3. True to a line: Do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
  - 4. Variation in cross-sectional dimensions or elevations: Shall not exceed minus 1/4 inch, plus 1/2 inch.
  - 5. Alignment of columns and walls (bottom versus top):
    - a. Bearing walls: 1/2 inch.
    - b. Non-bearing walls: 3/4 inch.
  - 6. Grout space or cavity width: Minus 1/4 inch, plus 3/8 inch.
  - 7. Variation in mortar joint thickness:
    - a. Do not exceed bed joint thickness indicated by more than plus/minus 1/8 inch, with maximum thickness limited to 1/2 inch.
    - b. Do not exceed head or collar joint thickness indicated by more than minus 1/4 inch or plus 3/8 inch.

### 3.14 CLEANING

- A. Dry brush masonry surfaces after mortar has set at end of each work day and after final pointing.
- B. Clean exposed, unglazed masonry with stiff brush and clean water, or with mild cleaning agent approved by Architect and unit manufacturer.
- C. Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.
- D. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
- E. Protect adjacent surfaces from contact with cleaner by covering with liquid strippable masking agent, polyethylene film, or waterproof masking tape.

- F. Saturate wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.

### **3.15 PROTECTION**

- A. Provide final protection and maintain conditions in manner acceptable to installer, which ensures unit masonry Work being without damage and deterioration at time of substantial completion.
- B. Uniform floor, roof loading: Do not apply for at least 12 hours after building masonry walls or columns.
- C. Concentrated loads: Do not apply for at least 3 days after building masonry walls or columns.

### **3.16 WASTE MANAGEMENT**

- A. Separate and recycle waste materials in accordance with the Waste Management Plan to the maximum extent economically feasible.
- B. Fold up metal banding, flatten, and place in designated area for recycling.
- C. Collect wood packing shims and pallets and place in designated area.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill or in landscaping of the Project, and other masonry waste, and legally dispose of off Owner's property.
- E. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed:
  - 1. Crush masonry waste to less than 4 inches in each dimension.
  - 2. Mix masonry waste with at least 2 parts of specified fill material for each part of masonry waste.
  - 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

**END OF SECTION**

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## SECTION 04 21 26

### GLAZED STRUCTURAL CLAY TILE MASONRY

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. System Description: Work described in this section covers requirements for Structural Glazed Tile Unit Masonry and its installation and maintenance.

##### 1.02 REFERENCES

- A. Applicable standards of the following as referenced:
  1. American Society for Testing and Materials (ASTM)
  2. Brick Industry Association (BIA)
  3. Underwriters Laboratories, Inc. (UL)
  4. Ceramic Glazed Masonry Institute (CGMI)
  5. Building Code Requirements for Masonry Structures (ACI 530-05/ASCE 5-05/TMS 402-05)

##### 1.03 DEFINITIONS

- A. Terms
  1. Structural Glazed Tile: SGT, extruded and manufactured clay masonry unit with a ceramic glazed face that is a structural unit which can be loadbearing masonry.
  2. Glazed Face: Exposed ceramic glazed face(s) on SGT.
  3. Bed Joint: Horizontal mortar joint between two SGT.
  4. Head Joint: Vertical mortar joint between two SGT.

##### 1.04 SUBMITALS:

- A. Samples: Submit samples for color selection from manufacturers full range.
- B. Certificates:
  1. Material Safety Data Sheet (MSDS)
  2. Certification Letter: Submit a certified letter from manufacturer prior to delivery of SGT to jobsite for compliance of specification requirements.

##### 1.05 DELIVERY, STORAGE AND HANDLING:

- A. Deliver SGT to jobsite as packaged by manufacturer. Offload SGT packages using equipment that will not damage SGT. No SGT is allowed to be in direct contact with the ground. Do not double stack cubes of SGT.
- B. Cover SGT with non-staining waterproof membrane covering. Keep units dry. Allow air circulation around stacked units. Installation of wet or stained SGT is prohibited.
- C. Keep SGT units in the individual cardboard packaging provided by the manufacturer until the unit is ready to be laid in the wall. Never use brick tongs or "pitch" the SGT to upper levels of scaffolding.

##### 1.06 PROJECT CONDITIONS:

- A. Take all precautions necessary to protect units from damage.
- B. Handle and store in protective cartons or trays until actual installation in the wall.
- C. Damaged units will not be accepted in the wall.

## **PART 2 PRODUCTS:**

### **2.01 STRUCTURAL GLAZED TILE:**

- A. Pattern or Type:
  - 1. Stack bond.
- B. Characteristics:
  - 1. Meet ASTM C-126 for grade (S) Select quality.
  - 2. Must meet ASTM C-84 (UL723) requirements and rated zero flame spread, zero smoke developed and zero fuel contribution. Also will not release any toxic or noxious fumes when burned at 2000°F (1093°C).
  - 3. Nominal Face stretcher dimensions standard 6T Series: 5-1/3-inch height by 12 inches.
  - 4. Nominal Bed Depths: As required.
  - 5. Shapes: Furnished as shown on the plans in accordance with manufacturers current standard production. All external corners, sills and jambs shall be bullnose (or square), unless otherwise noted. Lintels and internal corners shall be square (or bullnose), unless otherwise noted. The base course is straight (or coved) as shown on the drawings.
  - 6. Color to be selected by Architect / Engineer from current standard color offering to match existing tile.
  - 7. Approved manufacturer:
    - a. Elgin Butler Company, Elgin, Texas, (512) 285-3356.
    - b. Or approved equal.

### **2.02 ACCESSORIES:**

- A. Joint Reinforcement: for stack bonding pattern on a bearing wall, or as required, use continuous horizontal joint reinforcement in lengths of 10 to 12 feet (3 to 4 m). Use #9-gauge wire or 3/16 inch (5 mm) diameter wire. Ladder-type (or Tab-type) horizontal joint reinforcement recommended. Masonry joint reinforcing as specified in Masonry Accessories section.

## **PART 3 EXECUTION:**

### **3.01 INSTALLATION**

- A. Workmanship:
  - 1. Lay only dry masonry units.
  - 2. Lay masonry plumb, level and true to line.
  - 3. Lay units in stacked bonding pattern.
  - 4. Cut units with masonry saw using a wet diamond blade. Do not use units less than 4 inches in length.
- B. Mortar Joints:
  - 1. Lay joints of each first course in full width bed of mortar.
  - 2. Horizontally cored units:
    - a. Bed Joint: Full
    - b. Head Joint: Face shell thickness.
  - 3. Vertically cored units:
    - a. Bed Joint: Face shell thickness.
    - b. Head Joint: Full
  - 4. Remove and replace mortar with fresh mortar where adjustment must be made after mortar has started to set.
  - 5. Keep bed and head joints uniform in width, except for minor variations required to maintain bond and locate returns.
  - 6. Both bed and head mortar joints standard thickness of 3/8" (10mm) except for 6T Series use 5/16-inch (8mm), +/- 1/16-inch (1.6mm) or to course out with the existing material.

- C. Joint Treatment:
  - 1. Tool or strike mortar joints on exposed face when they are "thumb print" hard.
  - 2. Tool all SGT joints concave using a non-metallic tool 1-1/4 inches (31mm) in diameter or larger unless otherwise noted.
  - 3. Sanitary Epoxy Mortar, where required:
    - a. Rake mortar joints 1/4-inch (6mm) to 3/8-inch (10mm) deep. Mix and install vertical wall, non-sag sanitary epoxy grout in strict accordance with manufacturer's directions.
- D. Removal of Existing Structural Glazed Tile:
  - 1. Cut out existing material where indicated on the drawings. Do not leave pieces of tile in the wall smaller than 4 inches (101mm) in length. Use care in cutting out units at the mortar joints as to not chip the existing tile. Chips larger than a 3/8-inch (10mm) square will require replacement of the units. Smaller chips may be repaired. Contact the manufacturer for instructions.

### 3.02 APPLICATION:

- A. Acceptable Tolerances:
  - 1. Walls must be straight in plane.
  - 2. Maximum variation from plumb: 1/4 inch (6mm) in 10' 0" (3.05m); not exceeding 3/8 inch (10mm) in 20' 0" (6.1m).
  - 3. Maximum variation from level: 1/4 inch (6mm) in 20' 0" (6.1m); not exceeding 1/2 inch (13mm) in 40' 0" (12.2m) or more.
  - 4. Maximum variation in linear building line from location indicated: 1/4 inch (6mm) in 20' 0" (6.1m).

### 3.03 CLEANING:

- A. It is intended that with careful adherence to this specification that extensive final cleaning will not be necessary.
- B. During construction, wipe glazed surface clean after tooling of joints or within 30 minutes after laying, with course rag. Keep wall clean as work progresses to avoid more difficult cleanup later. Use no metal scrapers, abrasive powders or unauthorized cleaning agents. Use wooden paddles or scrapers to clean away mortar residue or lumps. Wash with clean water. A mild detergent may be used. Rinse with clean water. Wipe with clean cloths, sponges or similar item.
- C. In event of unexpected contaminations of SGT walls, perform any cleaning with other than a non-metallic scraper, stiff nylon or natural bristled brush or wooden paddle only after approval by Architect and necessary tests to insure against any wall damage.

**END OF SECTION**

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## SECTION 05 31 00

### STEEL DECKING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Roof deck.
  - 2. Shop priming.
  - 3. Steel deck accessories including, but not limited to:
    - a. Shear connectors.
    - b. Metal cover plates.
    - c. Metal closure strip.
    - d. Flexible closure strip.
    - e. Roof drain sump pans.
    - f. Hanger slots or clips.
- B. Furnish the following for other sections to install including, but not limited to:
  - 1. Acoustical sound batts.
- C. Perform the following:
  - 1. Provide openings, located by others, in decking.
- D. Related Sections:
  - 1. Section 03 30 00 - Cast-in-Place Concrete
  - 2. Section 05 05 24 - Capacitor Discharge Stud Welding
  - 3. Section 05 50 00 - Metal Fabrications
  - 4. Section 07 51 13 - Built-up Asphalt Roofing
  - 5. Section 07 53 23 - EPDM Membrane Roofing
  - 6. Section 09 91 00 - Painting
  - 7. Section 09 91 50 - Shop Painting
- E. Alternates: Refer to Section 01 23 00.
- F. Unit Prices: Refer to Section 01 27 00.

##### 1.02 REFERENCES

- A. Industry Standards:
  - 1. AISI - Specifications for the Design of Cold-Formed Steel Structural Members
  - 2. AWS D1.3 - Structural Welding Code - Sheet Steel
  - 3. SDI - Design Manual for Floor Decks and Roof Decks
- B. ASTM:
  - 1. A36 - Carbon Structural Steel
  - 2. A108 - Steel Bar, Carbon and Alloy, Cold-Finished
  - 3. A653 - Steel Sheet, Galvanized or Galvannealed by Hop Dip Process
  - 4. A570 - Roof Systems Assemblies Employing Steel Deck, Preformed Insulation, and Bituminous Built-up Roofing
  - 5. A780 - Repair of Damaged and Uncoated Areas of Galvanized Coatings
  - 6. A1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low-Alloy, Improved Formability, Solution-Hardened, and Bake Hardable
  - 7. E119 - Fire Tests of Building Construction Materials



### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Manufacturer's specifications, installation instructions for each type of decking and accessories. Include manufacturer's certification to show compliance with Specifications.
- C. Shop Drawings:
  - 1. Show system fabrication, installation drawings, including plans, elevations, sections details of components, joint locations and configurations within system and between system and adjoining system.
  - 2. Show layout and types of deck panels, anchorage details, conditions requiring closure panels, supplementary framing, sump pans, cant strips, cut openings, special jointing or other accessories.
- D. Insurance Certification: Assist Owner in preparation and submittal of roof installation acceptance certification in connection with fire and extended coverage insurance.
- E. Certificates: Provide AWS D1.1 certification for welders.

### 1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of referenced standards.
- B. Field Welding: Qualify welding processes and welding operators in accordance with procedures of AWS D1.3.
- C. Underwriters' Label:
  - 1. Fire Resistance: Provide metal floor deck units listed in Underwriters' Laboratories "Fire Resistance Directory," with each deck unit bearing the UL label and marking for specific system detailed.
  - 2. Electrical Construction: Provide cellular floor deck units listed in UL "Electrical Construction Materials Directory" with each cellular metal floor deck unit bearing UL labels and marking. Provide units that will permit use of standard header ducts and outlets for electrical distribution systems.
- D. FM Listing: Provide metal roof deck units that have been evaluated by Factory Mutual System and are listed in "Factory Mutual Approval Guide" for "Class I" fire rated construction.
- E. Experience:
  - 1. Manufacturer: 10 years experience in the manufacture of Steel Decking.
  - 2. Contractor: 3 years experience in the installation of Steel Decking.

### 1.05 PROJECT CONDITIONS

- A. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## PART 2 PRODUCTS

### 2.01 METAL DECK

- A. Standard of Quality: Design is based on products of Vulcraft/Div. Nucor Corp.
- B. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
  - 1. United Steel Deck, Inc.
  - 2. Wheeling Corrugating Co.
  - 3. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Steel for Painted Metal Deck Units: ASTM A1008, Grade C.
- B. Steel for Galvanized Metal Deck Units: ASTM A153, Grade A.
- C. Miscellaneous Steel Shapes: ASTM A36.
- D. Sheet Metal Accessories: ASTM A1008, commercial quality, galvanized.
- E. Galvanizing: ASTM A653, G60.
- F. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Military Specifications MIL-F-21035 (Ships).

## 2.03 STEEL DECKING

- A. Roof Deck Units: Provide deck configurations complying with referenced SDI standard of metal thickness, depth, width as shown.
- B. Steel Decking Accessories:
  - 1. Metal Closure Strips:
    - a. Fabricate metal closure strips, for cell raceways and openings between decking and other construction.
    - b. Minimum 0.045-inch (18 gage) sheet steel.
    - c. Form to provide tight-fitting closures at open ends of cells or flutes and sides of decking.
  - 2. Flexible Closure Strips: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.
  - 3. Roof Sump Pans:
    - a. Fabricate from single piece of 0.071-inch minimum (14 gage) galvanized sheet steel with level bottoms, sloping sides to direct water flow to drain, unless otherwise shown.
    - b. Of adequate size to receive roof drains.
    - c. Bearing flanges not less than 3 inches wide.
    - d. Recess pans not less than 1-1/2 inches below roof deck surface, unless otherwise shown or required by deck configuration.
    - e. Cut holes for drains in the field.
  - 4. Acoustic Sound Batts:
    - a. Inert, non-organic glass fiber sound absorbing batts.
    - b. Provide strips to fit void space between vertical ribs.
- C. Shop Painting:
  - 1. Refer to Section 09 91 50.
  - 2. Materials:
    - a. Typical: Red oxide primer with less than 100 parts per million of lead, mercury, cadmium or hexavalent chromium.
    - b. Surfaces to Receive Fireproofing: In addition to above, shop paint only with materials that are approved by the fireproofing manufacturer in compliance with UL or FM assemblies.
  - 3. Remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories before applying shop paint.
  - 4. Apply one shop coat of primer paint to steel joists and accessories by spray, dipping, or other method.
  - 5. Provide minimum continuous dry paint film thickness of 0.50 mil.
  - 6. Verify shop primer is compatible with field finishes.

## **PART 3 EXECUTION**

### **3.01 FIELD QUALITY CONTROL**

- A. Comply with requirements of Section 01 45 10 for special inspection and testing frequency and responsibilities.
- B. Steel special inspections shall be in accordance with SDI Quality Control and Quality Assurance for Installation of Steel Deck.
- C. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- D. Verification of Conditions: Verify that Steel Decking may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- E. Discrepancies: Immediately notify Engineer. Do not proceed with installation in areas of discrepancy until fully resolved. Commencement of installation signifies acceptance of surface conditions.

### **3.02 INSTALLATION**

- A. General Requirements: Install in accordance with manufacturer's recommendations, final Shop Drawings, and as specified.
  - 1. Place on supporting steel framework, adjust to final position with ends accurately aligned, bearing on supporting members before being permanently fastened.
  - 2. Do not stretch or contract side lap interlocks.
  - 3. Place in straight alignment for entire length of run of cells, close alignment between cells at ends of abutting units.
  - 4. Place flat and square, secured to adjacent framing without warp, excessive deflection.
  - 5. Do not place on concrete supporting structure until concrete has cured and is dry.
  - 6. Coordinate and cooperate with structural steel erection in locating decking bundles to prevent overloading of structural members.
  - 7. Do not use floor deck units for storage or working platforms until permanently secured.
- B. Fastened Deck Units:
  - 1. Fasten roof deck units to steel supporting members by not less than 1/2-inch diameter fusion welds or elongated welds of equal strength, spaced not more than 12 inches on center at every support, or as indicated on Drawings, and at closer spacing where required for lateral force resistance.
  - 2. Secure deck to each supporting member in ribs where side laps occur. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance, quality of welds, methods used in correcting welding work. Use welding washers where recommended by deck manufacturer.
  - 3. Mechanically fasten side laps of adjacent deck units between supports, at intervals not exceeding 36 inches on center, using self-tapping No. 8 or larger machine screws.
- C. Uplift Loading: Install and anchor roof deck units to resist gross uplift loading of 45 pounds per square feet at eave overhang and 30 pounds per square feet for other roof areas.
- D. Cutting and Fitting: Cut and neatly fit around other work projecting through or adjacent to decking, as shown.
- E. Reinforcement at Openings: Provide additional metal reinforcement, closure pieces as required for strength, continuity of decking, support of other work shown.
- F. Closure Strips: Provide at open uncovered ends and edges of roof decking, in voids between decking and other construction. Weld into position to provide complete decking installation.

- G. Touch-up Painting:
  - 1. Typical: After decking installation, wire brush, clean, paint scarred areas, welds, rust spots on top and bottom surfaces of decking units and supporting steel members.
  - 2. Touch-up painted surfaces with same type of shop paint used on adjacent surfaces.
  - 3. In areas where shop-painted surfaces are to be exposed, apply touch-up paint to blend into adjacent surfaces.
  - 4. Surfaces to be Fireproofed: Verify type of paint to be used.
  - 5. Touch-up damage to galvanizing with ZRC or similar zinc paint, minimum two coats.
  
- H. Acoustical Sound Batts:
  - 1. Install batts in:
    - a. Acoustical cellular floor deck.
    - b. Multiple-pan cellular roof deck.
  - 2. Provide batts for installation by others in single pan roof deck.
  
- I. Joint Covers: Provide at abutting ends and changes in direction of floor deck units, except where taped joints are required.
  
- J. Roof Drain Sump Pans:
  - 1. Provide openings location by plumber in roof decking.
  - 2. Place sump pans over openings, weld to top decking surface.
  - 3. Space welds not more than 12 inches on center with at least one weld at each corner.
  - 4. Cut opening in roof sump bottom to accommodate drain size indicated.
  
- K. Hanger Slots or Clips: Provide UL-approved punched hanger slots between cells or flutes of lower element where floor deck units are to receive hangers for support of ceiling construction, air ducts, diffusers, or lighting fixtures.

**END OF SECTION**

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## SECTION 05 50 00

### METAL FABRICATIONS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Aluminum ladders.
  - 2. Miscellaneous metal framing and supports.
  - 3. Metal fabrication accessories including, but not limited to:
    - a. Rough hardware.
    - b. Grout and anchoring cement.
- B. Furnish the following for other sections to install including, but not limited to:
  - 1. Loose bearing and leveling plates.
  - 2. Pipe bollards.
  - 3. Floor anchor pots and plates.
  - 4. Metal fabrication accessories including, but not limited to:
    - a. Rough hardware.
- C. Related Sections:
  - 1. Section 03 30 00 - Cast-in-Place Concrete
  - 2. Section 03 41 00 - Plant-Precast Structural Concrete
  - 3. Section 04 20 00 - Unit Masonry Assemblies
- D. Alternates: Refer to Section 01 23 00.
- E. Unit Prices: Refer to Section 01 27 00.

##### 1.02 REFERENCES

- A. Building Codes:
  - 1. International Building Code
  - 2. State Building Code
- B. Aluminum Association:
  - 1. Aluminum Design Manual
- C. ASTM:
  - 1. A27 - Steel Carbon Castings, General Applications
  - 2. A36 - Carbon Structural Steel
  - 3. A47 - Ferritic Malleable Iron Castings
  - 4. A48 - Gray Iron Castings
  - 5. A53 - Pipe, Steel, Black, Hot Dipped, Zinc Coated, Welded, Seamless
  - 6. A123 - Zinc Coatings on Iron and Steel Products
  - 7. A153 - Zinc Coatings on Iron and Steel Hardware
  - 8. A167 - Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strips
  - 9. A500 - Cold-Formed, Welded and Seamless Carbon Steel Structural Tubing
  - 10. A501 - Hot-Formed, Welded and Seamless Carbon Steel Structural Tubing
  - 11. A536 - Ductile Iron Castings
  - 12. A653 - Steel Sheet, Galvanized or Galvannealed by Hot Dip Process
  - 13. A780 - Repair of Damaged Galvanized Coatings
  - 14. A786 - Hot Rolled Carbon, Low Alloy, High Strength Low Alloy, and Alloy Steel Floor
  - 15. A992 - Structural Steel Shapes
  - 16. A1008 - Steel Sheet, Cold Rolled, Carbon, Structural High Strength, Low Alloy

17. B209 - Aluminum and Aluminum-Alloy Sheet and Plate
18. B221 - Aluminum-alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
19. B308 - Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
20. B429 - Aluminum-Alloy Extruded Structural Pipe and Tube
21. B483 - Aluminum and Aluminum-Alloy Drawn Tubes
22. B632 - Aluminum Alloy Rolled Tread Plates
23. E119 - Test Method for Fire Tests of Building Construction and Methods
24. G90 - Standard for Performing Outdoor Weathering of Nonmetallic Materials Using Sun

D. AWS:

1. D1.1 - Structural Welding Code - Steel
2. D1.2 - Structural Welding Code - Aluminum
3. D1.3 - Structural Welding Code - Sheet Metal

E. NAAMM:

1. Metal Finishes Manual
2. MBG 531 - Metal Bar Grating Manual

F. SSPC:

1. PA1 - Paint Application Specification No. 1
2. SP3 - Power Tool Cleaning
3. SP6 - Commercial Blast Cleaning

### 1.03 DEFINITIONS

- A. Metal Fabrications: Items made from iron, steel, and aluminum shapes, plates, bars, strips, tubes, pipes, castings not part of structural steel or other metal systems specified elsewhere.

### 1.04 SYSTEM DESCRIPTION

- A. Performance Requirements: Design, engineer, fabricate, and install the following metal fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections.
1. Ladders: Concentrated vertical load of 400 pounds and concurrent lateral load of 100 pounds applied at any point on any rung vertically. Adequate bracing provided to withstand incidental lateral loads for strength and deflection.
  2. Design Standards: Design and construct in strict compliance with the requirements of OSHA and the International Building Code.
  3. Miscellaneous structures as indicated in the General Structural Notes of the structural drawings, or as indicated on the structural plans.

### 1.05 SUBMITTALS

- A. Product Data: Data for products used, including paint products and grout.
- B. Shop Drawings:
1. Detail fabrication, erection of each metal fabrication indicated. Include plans, elevations, sections, details of metal fabrications, their connections. Show anchorage and accessory items.
  2. Provide templates for anchors, bolts specified for installation under other sections.
- C. Calculations:
1. Where indicated to comply with certain design loadings, include structural computations, material properties, other information needed for structural analysis, signed and sealed by qualified professional engineer, registered in the state where project is located, responsible for their preparation.
  2. Submit calculations with the shop drawings they accompany, otherwise shop drawings will be rejected without review.
- D. Welder Certificates: Signed by Contractor certifying that welders comply with specified requirements.

- E. Qualification Data: For firms and persons specified, to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

## 1.06 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Fabricator: Firm experienced in successfully producing metal fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.
  - 2. Installer: Arrange for installation of metal fabrications specified in this section by same firm that fabricated them.
  - 3. Welding Processes and Welding Operators:
    - a. Qualify in accordance with AWS D1.1 "Structural Welding Code - Steel," D1.3 "Structural Welding Code - Sheet Steel," and D1.2 "Structural Welding Code - Aluminum."
    - b. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

## 1.07 SITE CONDITIONS

- A. Field Measurements:
  - 1. Check actual locations of walls, other construction to which metal fabrications must fit, by accurate field measurements before fabrication.
  - 2. Show recorded measurements on final Shop Drawings.
  - 3. Coordinate fabrication schedule with construction progress to avoid delay of Work.
  - 4. Where field measurements cannot be made without delaying Work, guarantee dimensions, proceed with fabrication without field measurements.
  - 5. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

## 1.08 SEQUENCING AND SCHEDULING

- A. Coordinate installation of anchorages for gratings, grating frames, and supports.
- B. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
- C. Coordinate installation of embed plates for metal fabrications with concrete and precast supplier.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Floor Opening Covers Anti-Slip Coating: Available Manufacturers, subject to compliance with requirements and prior approval by Engineer, include the following:
  - 1. SlipNOT [www.slipnot.com](http://www.slipnot.com)
  - 2. Mebac [www.mebac.com](http://www.mebac.com)
- B. Metal Bar Gratings: Available Manufacturers, subject to compliance with requirements and prior approval by Engineer, include the following:
  - 1. Alabama Metal Industries Corporation [www.amico-online.com](http://www.amico-online.com)
  - 2. Ohio Gratings, Inc. [www.ohiogratings.com](http://www.ohiogratings.com)
- C. Grout and Anchoring Cement:
  - 1. Approved Manufacturers: One of the following or approved in advance by Engineer.
  - 2. Non-shrink Metallic Grouts:
    - a. *Metox RM* by ChemMasters Corporation [www.chemmasters.net](http://www.chemmasters.net)



- b. *Hi-Flow Metallic Grout* by Euclid Chemical Company [www.euclidchemical.com](http://www.euclidchemical.com)
- c. *Embeco 636* by BASF [www.basfbuildingsystems.com](http://www.basfbuildingsystems.com)
- 3. Non-shrink Nonmetallic Grouts:
  - a. *Bonsal Construction Grout* by W. R. Bonsal Company [www.bonsal.com](http://www.bonsal.com)
  - b. *Hi-Flow Grout* by Euclid Chemical Company [www.euclidchemical.com](http://www.euclidchemical.com)
  - c. *Kemset* by ChemMasters Corporation [www.chemmasters.net](http://www.chemmasters.net)
  - d. *Crystex* by L & M Construction Chemicals, Inc. [www.lmcc.com](http://www.lmcc.com)
  - e. *Masterflow 713* by Unicon of BASF [www.unicon.ca](http://www.unicon.ca)
  - f. *SonogROUT* by BASF [www.basfbuildingsystems.com](http://www.basfbuildingsystems.com)
- 4. Erosion-Resistant Anchoring Cement:
  - a. "Super Por-Rok"; Minwax Construction Products Division
- 5. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Metal Fabrications Exposed to View:
  - 1. Provide materials selected for surface flatness, smoothness, and freedom from surface blemishes.
  - 2. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.
- B. Wide flange shapes and structural tees cut from: ASTM A992.
- C. Steel Shapes, Plates, and Bars: ASTM A36.
- D. Rolled Steel Floor Plates: ASTM A786.
- E. Gray Iron Castings: ASTM A48, Class 30.
- F. Malleable Iron Castings: ASTM A47, grade as recommended by fabricator for type of use indicated.
- G. Ductile Cast Iron Castings: ASTM A536, Grade 65-45-12.
- H. Steel Tubing: Cold-formed, ASTM A500; or hot-rolled, ASTM A501. For exterior installations and where indicated, provide tubing with hot-dip galvanized coating per ASTM A53.
- I. Structural Steel Sheet: Hot-rolled, ASTM E936; or cold-rolled ASTM 1008, Class 1; grade required for design loading.
- J. Galvanized Structural Steel Sheet: ASTM A653, grade required for design loading. Coating designation indicated; if not indicated, G90.
- K. Steel Pipe:
  - 1. ASTM A53; Type, Grade B, as required for design loading.
  - 2. Black finish unless galvanizing is indicated.
  - 3. Galvanized finish for exterior installations and where indicated.
  - 4. Standard weight (Schedule 40) unless otherwise indicated.
- L. All other steel shapes, plates and bars: ASTM A36.
- M. Brackets, Flanges, and Anchors: Cast or formed metal of same type material, finish as supported rails, unless otherwise indicated.
- N. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A47, or cast steel, ASTM A27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM 153.
- O. Stainless Steel: ASTM A167 W/No. 2B Mill Finish.

- P. Aluminum Grating: Alloy 6061-T6 or 6063-T6 ASTM B221, design required for span indicated on Drawings. Provide 19-P-4 grating unless noted otherwise.
- Q. Aluminum Rolled and Extruded Members, Tubing, Connectors: Alloy and Temper 6016-T6.

## 2.03 FABRICATION, GENERAL

- A. Forming:
1. Form from materials of size, thickness, shapes indicated, complying with performance requirements indicated.
  2. Work to dimensions indicated or noted on Shop Drawings.
  3. Form exposed work true to line, level, with accurate angles and surfaces and straight sharp edges.
- B. Cutting and Shaping:
1. Shear, punch metals cleanly, accurately. Remove burrs.
  2. Ease exposed edges to radius of approximately 1/32 inch unless otherwise indicated.
  3. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
  4. Remove sharp or rough areas on exposed traffic surfaces.
- C. Welding:
1. Comply with AWS recommendations.
  2. Use materials, methods to minimize distortion, develop strength and corrosion resistance of base metals.
  3. Fuse without undercut or overlap.
  4. Remove welding flux immediately.
  5. At exposed connections, finish exposed welds and surfaces smooth and blended.
- D. Joints:
1. Form exposed connections with hairline joints flush, smooth, using concealed fasteners wherever possible.
  2. Use exposed fasteners of type indicated or, if not indicated, Phillips flathead (countersunk) screws or bolts.
  3. Locate joints where least conspicuous.
- E. Anchorage:
1. Provide for type indicated; coordinate with supporting structure.
  2. Fabricate, space anchoring devices to provide adequate support for intended use.
- F. Joints: Fabricate joints exposed to weather in manner to exclude water, or provide weep holes where water may accumulate.
- G. Shop Assembly:
1. Preassemble in shop to greatest extent possible.
  2. Disassemble only as necessary for shipping, handling limitations.
  3. Use connections that maintain structural value of joined pieces.
  4. Clearly mark for reassembly and coordinated installation.
  5. Cut, reinforce, drill, tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.
- H. Finishes:
1. Comply with referenced NAAMM manual.
  2. Finish metal fabrications after assembly.

## 2.04 ALUMINUM LADDERS

- A. Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3.
- B. Rungs:
  - 1. Not less than 1-1/4 inches (32 mm) in section and 18-3/8 inches (467mm) long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
  - 2. Rungs shall withstand a 1,500-pound (454 kg) load without deformation or failure.
- C. Channel Side Rails: Not less than 1/8-inch (3 mm) wall thickness by 3 inches (76 mm) wide.
- D. Walk-Through Rail and Roof Rail Extension: Not less than 3 feet 6 inches (1067 mm) above the landing and shall be fitted with deeply serrated, square, tubular grab rails.
- E. Landing Platform: 1-1/2 inches (38 mm) or greater diameter, tubular aluminum guardrails and decks of serrated aluminum treads.
- F. Ladder Safety Post: Retractable hand hold and tie off.
- G. Support:
  - 1. Support each ladder at top and bottom and at intermediate points spaced not more than 5 feet on center by means of welded or bolted aluminum brackets.
  - 2. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.
  - 3. Extend side rails 42 inches above top rung, and return rails to wall or structure unless other secure handholds are provided.
- H. If the adjacent structure does not extend above the top rung, gooseneck the extended rails back to the structure to provide secure ladder access.

## 2.05 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel and aluminum items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area.
- B. Drill plates to receive anchor bolts and for grouting as required.
- C. Galvanize steel shapes after fabrication unless indicated otherwise.

## 2.06 PIPE BOLLARDS

- A. Fabricate pier set bollards from:
  - 1. Schedule 40 galvanized steel pipe.
  - 2. Length and size as indicated on the detail in the drawings.
  - 3. Provide HDPE sleeve and seal as indicated in the drawings.
  - 4. Provide base plate and anchor bolts at surface mounted bollard locations. Only use where specifically indicated.

## 2.07 METAL BAR GRATINGS

- A. Produce metal bar gratings of description indicated per NAAMM marking system that comply with the following:
  - 1. Metal Bar Grating Standard "Standard Specifications for Metal Bar Grating and Metal Bar Grating Treads" published in ANSI/NAAMM A202.1 "Metal Bar Grating Manual."
- B. Material:
  - 1. Unless indicated to be FRP, all grating shall be aluminum, mill finish.

2. 1 3/16 bearing bar spacing, 4-inch cross bar spacing UNO.
  3. Provide engineered calculations package where grating size is not specifically listed on plans. Where listed on plans, grating has been designed per MBG 531 and manufacturer's capacities shall meet or exceed the MBG 531 tabulated capacities.
- C. Fabrication:
1. Include anchors and fasteners of type indicated, or if not indicated, as recommended by manufacturer, for attachment to supports.
  2. Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Maximum weight of each removable section to be 100 pounds; size panels accordingly.
  3. Fabricate all bar grating above sump pits, tanks, channels, pits, etc. to allow for future removal. Use removable fasteners.
- D. Fasteners:
1. Provide not less than 4 saddle clips for each grating section composed of rectangular bearing bars 3/16-inch or less in thickness and spaced not less than 15/16-inch on center, with each clip designed and fabricated to fit over 2 bearing bars. Furnish threaded bolts with nuts and washers for each clip required.
  2. Provide not less than 4 anchor blocks for each section of heavy-duty grating composed of bearing bars over 3/16 inch in thickness, with each block shop-welded to 2 bearing bars.
- E. Cut Outs:
1. Fabricate cutouts in grating sections for penetrations indicated.
  2. Arrange layout of cutouts to permit grating removal without disturbing items penetrating gratings.
  3. All removable sections shall be provided with hand holes for manual lifting (two slots ground smooth on each end).

## 2.08 FLOOR OPENING COVERS

- A. Description:
1. Loose plates and tube-stiffened covers.
  2. All plates, angles, tubes, and connection accessories shall be aluminum unless noted otherwise.
  3. Refer to information on drawings.
  4. Panelize as necessary for fabrication, erection, and future maintenance. Shop drawings shall indicate panel sizes for approval.
  5. Where floor covers are indicated to be removable, fabricate in sections weighing no more than 100 pounds each. Provide hand holes for manual lifting (two slots ground smooth on each end).
  6. Distance between adjacent panels shall not exceed 1/8 inch. Provide keepers as necessary to keep covers from sliding.
- B. Coatings:
1. Provide electrically deposited aluminum anti-slip coating. 2. UL Listed: Slip-resistant.

## 2.09 GROUT AND ANCHORING CEMENT

- A. Rough Hardware:
1. Bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, other miscellaneous steel and iron shapes required for framing and supporting woodwork, anchoring or securing woodwork to concrete or other structures.
  2. Fabricate to sizes, shapes, dimensions required.
  3. Malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.
- B. Non-shrink Metallic Grout: Premixed, factory-packaged, (int. ferrous aggregate grout complying with CE CRD-C 621, only) specifically recommended by manufacturer for heavy duty loading applications of type specified in this section.

- C. Non-shrink Nonmetallic Grout: Premixed, factory-packaged, (non-staining, noncorrosive, nongaseous grout complying stain) with CE CRD-C 621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.
- D. Erosion-Resistant Anchoring Cement:
  - 1. Factory-prepackaged, non-shrink, non-staining, hydraulic expansion cement formulation for mixing with potable water at Site to create pourable anchoring, patching, and grouting compound.
  - 2. Provide formulation that is resistant to erosion from water exposure without need for protection by a sealer or waterproof coating and is recommended for exterior use by manufacturer.

## **2.10 LIFTING HOOK ASSEMBLIES**

- A. Locations and capacities as indicated on the drawings.
- B. Verify all lifting hook capacities and locations with approved process equipment.

## **2.11 MISCELLANEOUS FRAMING**

- A. Aluminum finish or steel with industrial 3-coat epoxy for all wastewater process structures (tanks, wet environments of process buildings, etc.).
- B. Galvanized steel for miscellaneous framing and supports in the following locations:
  - 1. Exterior locations unless indicated otherwise.

## **2.12 FINISHES**

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
  - 1. Refer to Section 09 91 00.
- B. Finish metal fabrications after assembly.
- C. Steel and Iron Finishes:
  - 1. Galvanizing: For those items indicated for galvanizing, apply zinc-coating by the hot-dip process in compliance with the following requirements:
    - a. ASTM A153 for galvanizing iron and steel hardware.
    - b. ASTM A123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299-inch thick and heavier.
    - c. Use process for galvanizing that will prepare item for painting
  - 2. Primer Application:
    - a. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated.
    - b. Comply with requirements of SSPC-PA1 "Paint Application Specification No. 1" for shop painting.
- D. Galvanizing Repair Paint: High zinc dust content; dry film containing at least 94 percent zinc dust by weight; comply with DOD-P-21035 or SSPC-Paint-20.
- E. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint-12 except containing no asbestos fibers.
- F. Preparation for Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated.

- G. Where aluminum will contact dissimilar metals, protect against galvanic action as follows:
  - 1. Where aluminum members are in contact with steel, prime and paint both aluminum and steel members or provide protective barrier between members as necessary.
  - 2. Where aluminum members are in contact with concrete, apply to the contact surfaces of the aluminum members a heavy coat of alkali resistant bituminous paint.
  - 3. Where aluminum members are embedded in concrete containing admixtures which are corrosive to aluminum, or in concrete subjected to highly corrosive environments, prime and paint surfaces as necessary.

## **PART 3 EXECUTION**

### **3.01 FIELD QUALITY CONTROL**

- A. Required Inspections: Comply with requirements of Section 01 45 10 for responsibilities and report requirements.
- B. Required steel inspections shall be in accordance with the quality assurance inspection requirements of AISC 360.
- C. Inspect Bolting and welding as required per IBC Chapter 1.
- D. Verification of Conditions: Verify that Metal Fabrications may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- E. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- F. Discrepancies: Immediately notify Engineer. Do not proceed with installation in areas of discrepancy until fully resolved. Commencement of installation signifies acceptance of surface conditions.

### **3.02 PREPARATION**

- A. Coordination:
  - 1. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.
  - 2. Coordinate delivery of such items to Site.
- B. Utilize templates and other systems required to ensure accurate placement of items that will be embedded in concrete and masonry.

### **3.03 INSTALLATION, GENERAL**

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Temporary Bracing: Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- E. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.

### **3.04 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS**

- A. Anchor supports securely to, and rigidly brace from, overhead building structure.

### **3.05 INSTALLATION OF METAL BAR GRATINGS**

- A. General: Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Removable Units: Secure removable units to supporting members with type and size of clips and fasteners indicated, or if not indicated as recommended by grating manufacturer for type of installation conditions shown.
- C. Non-removable Units: Secure non-removable units to supporting members by welding where both materials are the same; otherwise, fasten by bolting as indicated above.

### **3.06 INSTALLATION OF BOLLARDS**

- A. Anchor pier set bollards in cast concrete pier footing, providing not less than 6-inch uniform concrete coverage.
  - 1. Fill pipe core with concrete.
  - 2. Wrap pipe bollard with bond breaker prior to installation of paving or slabs.

### **3.07 TOLERANCES**

- A. Install in required position and within following tolerances:
  - 1. Maximum variation from plumb: 1/4-inch.
  - 2. Maximum offset from true alignment: 1/4-inch.
- B. Steel shall comply with the tolerances in section 05 12 00.

### **3.08 ADJUSTING AND CLEANING**

- A. Touch-Up Painting: Cleaning touch-up painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Section 09 91 00 of these specifications.
- B. Galvanizing: For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A780.
- C. Repair damage to coatings per manufacturer's recommendations.

D. Collect offcuts and scrap and place in designated areas for recycling.

**END OF SECTION**



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## SECTION 06 10 53

### MISCELLANEOUS ROUGH CARPENTRY

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Rooftop equipment bases and support curbs.
  - 2. Wood furring, grounds, nailers, and blocking.
- B. Related Sections:
  - 1. Section 07 53 23 - EPDM Membrane Roofing
  - 2. Section 07 62 00 - Sheet Metal Flashing and Trim
  - 3. Section 07 92 00 - Joint Sealants

##### 1.02 REFERENCES

- A. ASME:
  - 1. B18.6.1
  - 2. B18.2.1
- B. ASTM:
  - 1. A153 - Zinc-Coating (Hot-Dip) of Iron and Steel Hardware
  - 2. A307 - Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
  - 3. A563 - Carbon and Alloy Steel Nuts
  - 4. A653 - Galvanized Steel Sheet
  - 5. A666 - Annealed or Cold-Worked Austenitic Stainless Steel Sheet
  - 6. B633 - Electrodeposited Coatings of Zinc on Iron and Steel
  - 7. C954 - Steel Drill Screws for Application of Gypsum Panel Products to Steel Studs
  - 8. D3498 - Adhesives for Field Gluing Plywood to Lumber Framing
  - 9. E488 - Strength of Fasteners in Concrete and Masonry
  - 10. F593 - Carbon and Alloy Steel Externally Threaded Metric Fasteners
  - 11. F594 - Stainless Steel Nuts
  - 12. F1667 - Driven Fasteners
- C. AWPA U1 - Preservative Treatment by Pressure Process.
- D. APA The Engineered Wood Association Form E30 - APA Design/Construction Guide.
- E. Council of American Building Officials (CABO) NER-272 - Pneumatic or Mechanically Driven Staples, Nails, P-Nails and Allied Fasteners for Use in All Types of Building Construction.
- F. U.S. Department of Commerce (DOC), National Institute of Standards and Technology:
  - 1. PS1 - U.S. Product Standard for Construction and Industrial Plywood.
  - 2. PS2 - Performance Standard for Wood-Based Structural-Use Panels.
  - 3. PS20 - American Softwood Lumber Standard.
- G. Western Wood Products Association - Grading rules.

##### 1.03 DEFINITIONS

- A. Dimension Lumber: Surface nominal thickness of 2 to 4 inches and nominal width of 2 inches and wider.

## 1.04 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Submit for each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Wood Treatment Data: Provide chemical treatment manufacturer's instructions for handling, storing, installation, finishing.
- C. Quality Assurance/Control Submittals:
  - 1. Test Reports: Reports indicating and interpreting test results relative to compliance of fire-retardant-treated wood products with performance requirements indicated.
  - 2. Certifications:
    - a. Preservative-treated wood products: For each type include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, compliance with applicable standards, and instructions for handling, storing, installing, and finishing treated materials.
    - b. Waterborne-treated products: Include certification that moisture content of treated materials was reduced to levels indicated before shipment to Site.
    - c. Submit organic chemical formulation, third party inspected, ICBO and NER report, EPA registered as a preservative, with a builder's warranty.

## 1.05 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Contractor: 3 years experience in carpentry with 6 projects of similar size.
  - 2. Personnel: For actual installation, use personnel skilled in work required.

## 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.
- B. Protection:
  - 1. Keep materials under cover and dry.
  - 2. Protect from weather and contact with damp or wet surfaces.
  - 3. Stack lumber, plywood, and other panels, providing for air circulation within and around stacks and under temporary coverings.
  - 4. For lumber and plywood pressure-treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

## 1.07 PROJECT CONDITIONS

- A. Existing Conditions: Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Lumber, General:
  - 1. Lumber Standards: Comply with DOC PS 20, and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.
  - 2. Grade Stamps:
    - a. Factory mark each piece with grade stamp of inspection agency.

- b. For exposed lumber, furnish pieces with grade stamps applied to ends or back of each piece.
  - 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
  - 4. Provide dressed lumber, S4S, unless otherwise indicated.
  - 5. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal (38 mm actual) thickness or less, unless otherwise indicated, and lumber items not specified to receive wood preservative treatment.
- B. Wood-preservative-treated Materials:
- 1. Where lumber or plywood is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWWPA U1.
  - 2. Lumber not in contact with ground and protected from liquid water may be treated with inorganic boron (SBX).
  - 3. Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
  - 4. Use chemicals acceptable to authorities having jurisdiction and containing no chromium or arsenic.
  - 5. For exposed items indicated to receive stained finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
  - 6. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 pound per cubic foot. After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 and 15 percent, respectively.
  - 7. Treat indicated items and the following:
    - a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
    - b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
    - c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
    - d. Wood framing members less than 18 inches above grade.
    - e. Wood floor plates installed over concrete slabs on grade.
  - 8. Pressure treat wood members in contact with ground or freshwater with waterborne preservatives to a minimum retention of 0.40 pound per cubic foot.
- C. Dimension Lumber:
- 1. Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.
  - 2. Interior Partitions: Provide framing of the following grade and species:
    - a. Grade: 3, Construction, or Stud.
    - b. Species:
      - 1) Hem-fir north.
      - 2) Western woods.
  - 3. Other Framing: Provide the following:
    - a. Grade: 2, Construction, or Stud.
    - b. Species:
      - 1) Douglas fir-larch.
      - 2) Hem-fir north.
- D. Miscellaneous Lumber:
- 1. Provide lumber for support or attachment of other construction, including:
    - a. Blocking.
    - b. Nailers.
    - c. Rooftop equipment bases and support curbs.
    - d. Cants.
    - e. Furring.
    - f. Grounds.
    - g. Utility shelving.

2. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
  3. Grade:
    - a. For dimension lumber sizes, provide Grade 3 or Standard.
    - b. For board-size lumber, provide Grade 3, Common, or Standard.
  4. Species:
    - a. Douglas fir-larch.
    - b. Hem-fir north.
  5. Select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
  6. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.
- E. Fasteners:
1. Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
  2. Miscellaneous carpentry exposed to weather, in ground contact, or in area of high relative humidity: Provide fasteners with hot-dip zinc coating per ASTM A153 or of 304 stainless steel.
  3. Nails, Wire, Brads, and Staples: ASTM F1667.
  4. Power-Driven Fasteners: CABO NER-272.
  5. Wood Screws: ASME B18.6.1.
  6. Cold-Formed Metal Framing Screws: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
  7. Lag Bolts: ASME B18.2.1.
  8. Bolts: Steel bolts complying with ASTM A307, Grade A, with ASTM A563 hex nuts and, where indicated, flat washers.
  9. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete, determined by testing per ASTM E488.
    - a. Carbon-steel, zinc plated to comply with ASTM B633.
    - b. Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 3, grade A1 or A4.
- F. Metal Framing Anchors:
1. Provide galvanized steel framing anchors of structural capacity, type, and size indicated and acceptable to authorities having jurisdiction.
  2. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653, G60 (Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.
  3. 304 Stainless Steel Sheet: ASTM A666.
- G. Accessories:
1. Adhesives for gluing furring and sleepers to concrete or masonry.
    - a. Comply with ASTM D3498.
    - b. Approved for use indicated by adhesive manufacturer.
    - c. VOC content of 70 g/L or less.
  2. Other Materials: Materials not specifically described but required for complete, proper installation of miscellaneous carpentry, subject to acceptance of Engineer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.

- B. Verification of Conditions: Verify that miscellaneous carpentry may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies:
  - 1. Immediately notify Engineer in writing.
  - 2. Do not proceed with installation in areas of discrepancy until fully resolved.
  - 3. Commencement of installation signifies acceptance of surface conditions.

### 3.02 PREPARATION

- A. Protect installed work and materials of other trades.
- B. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- C. Apply field treatment complying with AWPAC M4 to cut surfaces of preservative-treated lumber and plywood.
  - 1. Use inorganic boron for items that are continuously protected from liquid water.
  - 2. Use copper naphthenate for items not continuously protected from liquid water.

### 3.03 INSTALLATION

- A. Installation, General:
  - 1. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
  - 2. Fit carpentry to other construction; scribe and cope as required for accurate fit.
  - 3. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
  - 4. Do not splice structural members between supports, unless otherwise indicated.
  - 5. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.
  - 6. Countersink nail heads on exposed carpentry work and fill holes with wood filler.
  - 7. Use fasteners of appropriate type and length, complying with Table 2304.9.1 "Fastening Schedule" in IBC. Predrill members when necessary to avoid splitting wood.
- B. Fire Blocking: Provide in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
  - 1. Furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches on center with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
  - 2. Concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches on center. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
  - 3. Concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 square feet and to solidly fill space below partitions.
  - 4. Concealed spaces behind combustible cornices and exterior trim at not more than 20 feet on center.
- C. Wood Grounds, Nailers, Blocking, and Sleepers:
  - 1. Install where shown and where required for screeding or attaching other work.
  - 2. Form to shapes indicated and cut as required for true line and level of attached work.
  - 3. Coordinate locations with other work involved.
  - 4. Attach to substrates to support applied loading.
  - 5. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
  - 6. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- D. Wood Furring:
  - 1. Install plumb and level with closure strips at edges and openings.
  - 2. Shim with wood as required for tolerance of finish work.

3. Furring to Receive Plywood or Hardboard Paneling: Install 1-inch by 3-inch nominal size furring at 24 inches on center.
4. Furring to Receive Gypsum Board or Plaster Lath: Install 1-inch by 2-inch nominal size furring vertically at 16 inches on center.

### **3.04 ADJUSTING**

- A. Replace damaged materials with new materials complying with specified requirements.

### **3.05 CLEANING**

- A. Site: Do not allow accumulation of scraps, debris arising from work of this Section. Maintain premises in neat, orderly condition.
- B. System:
  1. Remove temporary covering and other provisions made to minimize soiling of other work.
  2. Promptly clean, repair surfaces stained, marred or otherwise damaged during Work.
  3. When Work is completed, remove unused materials, containers, equipment, and debris.

### **3.06 PROTECTION**

- A. Protect wood treated with inorganic boron (SBX) from weather. If it becomes wet, apply EPA-registered borate treatment by spraying.
- B. Protect rough carpentry from weather. If it becomes wet, apply EPA-registered borate treatment by spraying.
- C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer to ensure work is without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

## SECTION 07 18 13

### PEDESTRIAN TRAFFIC COATING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Acceptable manufacturers, products and requirements for the installation of a waterproof, fluid-applied, pedestrian traffic-bearing, polyurethane coating system.

##### 1.02 RELATED REQUIREMENTS

- A. Section 07 62 00 – Sheet Metal Flashing and Trim
- B. Section 07 90 05 - Joint Sealants for joint sealants and accessories and joint preparation.

##### 1.03 REFERENCE STANDARDS

- A. International Concrete Repair Institute (ICRI): [icri.org](http://icri.org).
  - 1. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair
- B. Sealant, Waterproofing, and Restoration Institute (SWRI): [swrionline.org](http://swrionline.org).
  - 1. SWR Institute Validation Program.
- C. ASTM D 4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

##### 1.04 SUBMITTALS

- A. See Division 01, for submittal procedures.
- B. Product Data.
- C. Selection Samples: Three color charts illustrating available colors for initial selection.
- D. Verification Samples: Three samples minimum 4-inch square in size of coating mounted on plywood backing illustrating colors and textures selected.
- E. Manufacturer's written installation instructions.
- F. Field Adhesion Test Results in accordance with ASTM 4541, performed by coating manufacturer.

##### 1.05 GENERAL REQUIREMENTS

- A. Be responsible for protection of roof drains from entry of debris and coating, etc., and for ensuring that the drainage system remains free flowing throughout the course of Work.
- B. Prevent tracking of debris from surrounding areas into new work area where debris pieces can be trapped within the new deck system. Ensure that debris is not carried into new work areas on coating applicator's shoes or equipment wheels. Discovery of entrapped debris within deck system is sufficient cause for its rejection.



## **1.06 QUALITY CONTROL**

- A. Coating applicator must have a minimum of 3-year's successful experience in the application of similar systems.

## **1.07 SEQUENCING AND SCHEDULING**

- A. Preparation Work shall be limited to those areas that can be covered with the complete base coat application on same day or before arrival of inclement weather. Phasing of primer and base coat application will not be acceptable.
- B. Arrange Work sequence to avoid use of newly completed membrane for storage, walking surface, or equipment traffic. Move equipment and material storage areas as Work progresses.
- C. Allow no foot or equipment traffic over membrane until coating has cured.
- D. Repair any and all traffic-induced damage to the coating system the same day as the damage occurs.

## **1.08 ENVIRONMENTAL CONDITIONS**

- A. Do not apply polyurethane coating to deck surfaces below 40 degrees F., as measured by the surface pyrometer.
- B. Do not apply polyurethane coating in rain, snow, fog, mist or high humidity, as defined manufacturer's recommendations.
- C. Contractor is responsible for checking local-forecasting facilities to be assured that weather conditions (wind, rain, and humidity) are favorable before each day's operation begins.

## **PART 2 - PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. BASF Corp. Building Systems; [buildingsystems.basf.com](http://buildingsystems.basf.com).
- B. The Barrett Company LLC; [barrettroofs.com](http://barrettroofs.com).
- C. Neogard Construction Coatings; [neogard.com](http://neogard.com).
- D. Henry Company, [henry.com](http://henry.com).
- E. Pecora Corporation; [pecora.com](http://pecora.com).
- F. Sika Corporation U.S., [usa.sika.com](http://usa.sika.com).
- G. Tremco, Inc., [tremcosealants.com](http://tremcosealants.com).
- H. 3M, [3m.com](http://3m.com).

### **2.02 ACCEPTABLE PRODUCTS**

- A. Polyurethane coating system shall consist of primer and 3 coats of a one-part, moisture-cured, liquid-applied material which will cure to a polyurethane membrane.
  - 1. Masterseal Traffic 1500, by BASF;

2. HyppoCoat 100, by Barrett;
  3. Pumadeq, by Henry;
  4. Peda-Gard FC, by Neogard;
  5. Pecora-Deck 800 Series, by Pecora;
  6. Sikalastic 710/715 Traffic System, by Sika;
  7. Vulkem 350NF/950NF/951 NF, by Tremco.
  8. See Division 01, for substitution requirements.
- B. Primer for coating application on exposed concrete surfaces:
1. Masterseal P 222, by BASF;
  2. HyppoCoat TC, by Barrett;
  3. Pumadeq Primer 20, by Henry;
  4. 7760/7761, by Neogard;
  5. P-801-VOC, by Pecora;
  6. Sikalastic Primer, by Sika;
  7. Vulkem Primer #171, by Tremco.
  8. See Division 01, for substitution requirements.
- C. "Moveable" joint primer/detailing material:
1. MasterSeal P 173, by BASF;
  2. Liquid Flash 100, by Barrett;
  3. Pumadeq Flex 30SL, by Henry;
  4. FC7500/FC7960, by Neogard;
  5. Dynapoxy Low-Mod Epoxy, by Pecora;
  6. Sikalstic 710, by Sika;
  7. Dynamic 100, by Tremco.
  8. See Division 01, for substitution requirements.
- D. Base and lock coat materials shall be of contrasting color (or tinted) but shall have the same properties.
1. Base coat material:
    - a. Masterseal M200, by BASF;
    - b. HyppoCoat 100, by Barrett;
    - c. Pumadeq Flex 30SL, by Henry;
    - d. FC7500/FC7960, by Neogard;
    - e. Dynapoxy Low-Mod Epoxy (802 Base Coat optional), by Pecora;
    - f. Sikalastic 710 Base, by Sika;
    - g. Vulkem 350NF, by Tremco.
    - h. See Division 01, for substitution requirements.
  2. Intermediate coat material as required to properly adhere aggregate:
    - a. Masterseal T225, by BASF;
    - b. HyppoCoat 100, by Barrett;
    - c. PumadeqGrip 40, by Henry;
    - d. FC7510/FC7961, by Neogard;
    - e. 804 Intermediate Coat, by Pecora;
    - f. Sikalastic 715, by Sika;
    - g. Vulkem 950NF, by Tremco.
    - h. See Division 01, for substitution requirements.
  3. Top coat:
    - a. Masterseal T225 TB, by BASF;
    - b. HyppoCoat TC, by Barrett;
    - c. Henry Deqcoat 50, by Henry;
    - d. FC7540/FC7964, by Neogard;
    - e. 806 Top Coat, by Pecora;

- f. Sikalastic 715, by Sika;
- g. 951NF, by Tremco.
- h. See Division 01, for substitution requirements.

## **2.03 ACCESSORY MATERIALS**

- A. Aggregate:
  - 1. Granule surfacing: uniformly graded (16/30 mesh) hard aggregate having a minimum hardness of 6.5+ on Moh's scale. Color to match coating.
    - a. Masterseal 941, by BASF.
    - b. 7992, by Neogard.
    - c. 3M #11 Grade, ceramically-colored minerals, by 3M, Specified Construction Products Department.
    - d. See Division 01, for substitution requirements.
- B. Backer Rod: A closed-cell compressible backup material.
  - 1. As recommended by coating manufacturer.
- C. Polyurethane sealant: One-part, gun-grade polyurethane sealant as supplied by coating manufacturer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that:
  - 1. Substrate is properly prepared and free of foreign particles prior to installing polyurethane deck coating system.
  - 2. Conditions are satisfactory for proper installation of Work. Do not begin Work until unsatisfactory conditions have been corrected.
  - 3. Work of other trades requiring workers and equipment to traverse roof deck has been completed prior to installing the polyurethane roof system.

### **3.02 SURFACE PREPARATION**

- A. Complete topping slab and adjacent concrete repairs and/or replacement throughout anticipated working area each day prior to any polyurethane coating application.
- B. Sweep area clean of dirt and debris prior to application of the polyurethane coating system.
- C. Abrasive air-blast all surfaces with silica sand or slag. Abrade by hand where necessary.
- D. Power wash all surfaces to receive coating and allow to dry thoroughly.
- E. Concrete deck requires a medium sandpaper finish equal or greater than an ICRI CSP#3 (see sample in Construction Drawings).
- F. Cracks or joint repair:
  - 1. Visible cracks/joints up to 1/16-inch in width shall be treated with "moveable" joint primer/detailing material, filling the crack to provide a smooth and uniform surface for the base coat.
  - 2. Larger cracks/joints shall be routed out, primed and sealed with polyurethane sealant; do not apply sealant to the deck surface. Joint shall be treated with "moveable" joint primer/detailing material prior to base coat application.
- G. Plug drainage tubes to avoid coating entry. Clean off foreign residue prior to applying coating.

- H. Apply primers, to surfaces which are to receive coating.
- I. Primer shall be applied in one coat at the rate recommended by manufacturer.
- J. Primer shall be dried free of solvent. Any areas where primer is ponding shall be removed down to the existing substrate and re-primed with one thin coat.
- K. Form a 45-degree cant with sealant at the base of curbs, walls and parapets. Prime with move- able primer before coating.
- L. Install sheet metal components in accordance with Section 07 62 00. Clean and prime metal surfaces prior to applying base coat.

### **3.03 FIELD ADHESION TEST**

- A. Perform a minimum of 3 tests (1 horizontal, 2 vertical) with acceptable results per area.

### **3.04 GENERAL WORKMANSHIP**

- A. Allow no foot or equipment traffic over the polyurethane coating during installation of the system. Applicator workmen shall be restricted to persons wearing "heal-less," soft-soled shoes.
- B. Periodically check the applied coating for thickness, adhesion, blisters, cracks, surface texture and mechanical damage. Any deviation from approved materials or application techniques shall be cause for rejection of all, or part of Work.

### **3.05 PRIMER APPLICATION**

- A. Apply primer at a rate of 1-gallon per 300 feet, with an air-less sprayer, brush, or phenolic resin core roller.
- B. Where any pin holes or small cavities are present, they should be filled with primer.
- C. Allow primer to be "thumb-print" hard before applying base coating.
- D. Apply each coat of coating system at wet film thickness recommended by manufacturer to result in fully cured waterproof pedestrian coating of specified dry film thickness.

### **3.06 BASE COAT APPLICATION**

- A. Apply first base coat as soon as possible after primer has been applied, in no case less than 1- hour or more than 8-hours.
- B. Apply base coat in a single pass at wet film thickness recommended by manufacturer. Allow base coat to cure before continuing with additional coating material.
- C. Extend coating over cants and up walls, curbs and penetrations a minimum of 8-inches above topping slab surface.
- D. Inspect cured base coat application for pinholes or other defects within membrane base coating. Touch-up and repair defects.

### **3.07 INTERMEDIATE COAT APPLICATION AND GRANULES**

- A. After the base coat has cured, apply 'lock' coat:
  - 1. Apply the 'lock' coat in single pass per manufacturer's recommended wet mil thickness.

2. Apply the coating at a uniform thickness so that granules will adhere at a uniform rate.
  3. Cover only an area that will allow granules to be applied within 5-minutes of the lock-coat application.
  4. Apply the granules, by hand broadcast, apply to refusal. Apply granules using a back and forth motion approximately 3- to 4-feet from the surface. Apply additional granules using an up and down motion until area is uniformly coated with granules. Slight excess of granules should be used.
- B. Whenever the coating process is stopped, the granule application should continue so that coated areas are coated with granules except for a 6 to 8-inch strip along the edge. On next pass, or when resuming coating after a shutdown, a normal application of fresh coating shall be applied to the "lap" edge left from the previous application.

### **3.08 TOP COAT APPLICATION**

- A. Over the completed 'lock' coat and granules, after review and approval by Consultant, apply 'wear' coat at wet film thickness recommended by manufacturer.
- B. Provide photos of mil-thickness test showing that Work-in-place meets or exceeds specified coating system thickness.

### **3.09 ADJUSTING AND CLEANING**

- A. Remove plugs from drain tubes and other applied masking.
- B. Repair of deficiencies: Installation or details noted as deficient during Final Review must be repaired and corrected by Contractor, and made ready for review again, within 5 working days.
- C. Clean-up: Immediately upon job completion, remove equipment, rubbish, scrap, debris and excess material from Project area.

**END OF SECTION**

## SECTION 07 21 00

### THERMAL INSULATION

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Rigid insulation.
  - 2. Spray foam sealant.
  - 3. Accessories including, but not limited to:
    - a. Tape.
- B. Related Sections:
  - 1. Section 03 30 00 Cast-In-Place Concrete

##### 1.02 REFERENCES

- A. ASTM:
  - 1. C236 - Measuring Steady-State Thermal Transmission of Fenestration Systems
  - 2. C272 - Water Absorption
  - 3. C578 - Rigid Cellular Polystyrene
  - 4. C1304 - Odor Emission of Thermal Insulation Materials
  - 5. C1338 - Fungi Resistance of Insulation Materials and Facings
  - 6. D882 - Tensile Properties of Thin Plastic Sheet
  - 7. D1621 - Compressive Properties
  - 8. D2126 - Dimensional Stability
  - 9. E84 - Surface Burning Characteristics of Building Materials
  - 10. E96 - Water Vapor Transmission of Materials
  - 11. E119 - Fire Tests of Building Construction and Materials
  - 12. E136 - Behavior of Materials in a Vertical Tube Furnace
  - 13. E970 - Critical Radiant Flux of Exposed Attic Floor Insulation

##### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data:
  - 1. Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.
  - 2. Include binders, additive, and expanding agent.
- C. Shop Drawings: Submit Shop Drawings showing system fabrication, installation drawings, including plans, elevations, sections details of components, joint locations and configurations within system and between system and adjoining system.

##### 1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide building insulation system made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
- B. Qualifications:
  - 1. Manufacturer: 5 years experience in the manufacture of building insulation.
  - 2. Contractor: 3 years experience in the installation of building insulation.

3. Personnel: For actual installation of building insulation, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.
- C. Regulatory Requirements:
1. Use aged and settled values for thermal resistance factors (R-values), tested in accordance with ASTM C518 at 75 degrees F and 50 percent relative humidity for at least 6 months.
  2. Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products by test method indicated below:
    - a. Surface-Burning Characteristics: ASTM E84.
    - b. Fire-Resistance Ratings: ASTM E119.
    - c. Combustion Characteristics: ASTM E136.

## 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources
- B. Store inside and in a dry location.
- C. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Plastic Insulation:
  1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
  2. Protect against ignition at all times.
  3. Do not deliver to Site before installation time.
  4. Complete installation and concealment as rapidly as possible in each area of construction.

## 1.06 PROJECT CONDITIONS

- A. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Rigid Board Insulation:
  1. Extruded Polystyrene:
    - a. Standard of Quality: Design is based on products of Owens Corning, Toledo, OH [www.owenscorning.com](http://www.owenscorning.com)
    - b. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
      - 1) Dow Chemical Company, Midland, MI
      - 2) Johns Manville [www.jm.com](http://www.jm.com)
      - 3) Minnesota Diversified Products, Inc., Rockford, MN
      - 4) Pactiv Corporation, Atlanta, GA
      - 5) Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- B. Tape:
  1. Standard of Quality: Design is based on *No. 8086 Contractor Sheathing Tape* by 3M, St. Paul, MN
  2. Other acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. *Sheathing Tape 1585CW-2* by VentureTape, Rockland, MA [www.venturetape.com](http://www.venturetape.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Rigid Board Insulation:
  - 1. Use preformed units to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.
  - 2. Extruded Polystyrene Board Insulation:
    - a. Rigid, cellular thermal insulation with closed-cells and integral high-density skin, formed by expansion of polystyrene base resin in extrusion process.
    - b. 5-year aged R-values (ASTM C518) 5.4 and 5 per inch at 40 and 5 degrees F respectively.
    - c. Dimensional stability (ASTM D2126) of 1.0 percent.
    - d. Water absorption (ASTM C272) of 0.15 percent (maximum).
    - e. Below grade insulation:
      - 1) Product: *Foamular 250*.
      - 2) Type: IV.
      - 3) Minimum density: 1.6 pounds per cubic foot unless otherwise indicated.
      - 4) Compressive resistance: 25 pounds per square inch.
- B. Accessories: All other materials not specifically described but required for complete and proper installation of building insulation subject to acceptance of Architect including, but not limited to:
  - 1. Spray Foam Sealant: Non-shrink closed cell expanding urethane.
  - 2. Tape:
    - a. 2 inches wide.
    - b. Self-adhesive vapor retarder tape.
    - c. Flame spread index of 25 or less, smoke developed index of 50 or less.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Work of Other Trades:
  - 1. Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
  - 2. Verify substrates are properly prepared and clean.
- B. Verification of Conditions: Verify that building insulation may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies:
  - 1. Immediately notify Architect.
  - 2. Do not proceed with installation in areas of discrepancy until fully resolved.
  - 3. Commencement of installation signifies acceptance of surface conditions.

### 3.02 INSTALLATION

- A. General:
  - 1. Install in accordance with manufacturer's instructions.
  - 2. Where taped joints are specified, completely seal joints between adjacent vapor retarders and between vapor retarders and adjacent construction.
  - 3. Install sound control insulation in manner to achieve and maintain the sound ratings specified.
  - 4. Water-piping coordination: If water piping is located on inside of insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
  - 5. Install insulation that is undamaged, dry, and unsoiled, and that has not been left exposed at any time to ice and snow.
  - 6. Minimize the generation of offcuts and waste. Reuse insulation scraps to maximum extent feasible.



- B. Rigid Board Insulation:
  - 1. Install in a clean, dry condition.
  - 2. Attach with adhesive specifically recommended for such use.
  - 3. Anchor with fasteners if recommended by the manufacturer and approved by Architect spaced 12 inches on center maximum.
  - 4. Use expanding foam sealant between insulation panels.
  - 5. Fill holes and openings.
- C. Other Insulation: Apply as indicated on Drawings or required by construction in such a manner to provide continuous barrier to movement of heat and air.

### **3.03 PROTECTION**

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

### **3.04 INSPECTION AND TESTING**

- A. Inspect insulation for proper installation.
- B. Correct defects such as voids, gaps, or insulation compressed behind pipes.

### **3.05 CLEANING**

- A. Clean construction area of all scrap insulation at the end of each working day.

**END OF SECTION**

## SECTION 07 21 29

### SPRAYED CELLULOSE THERMAL INSULATION

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Sprayed cellulose thermal insulation

##### 1.02 RELATED ITEMS

- A. Clips, hangers, supports, sleeves and other attachments to spray bases are to be placed by other trades prior to the application of sprayed insulation.
- B. Ducts, piping, conduit or other suspended equipment shall not be positioned until after the application of sprayed insulation.
- C. Roof penetrations to be installed prior to application.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturer must have a current Underwriters Laboratories (UL) Code Evaluation Report.
- B. Manufacturer must be in compliance with the 2015 International Building Code.
- C. Manufacturer must be ISO 9001:2015 Certified.
- D. Manufacturer must be Forest Stewardship Council (FSC) Chain-of-Custody Certified.
- E. Applicator: Licensed by manufacturer.
- F. Manufacturer must subscribe to independent laboratory follow-up inspection services of Underwriters Laboratories and Factory Mutual. Each bag shall be labeled accordingly.
- G. Mock-up: Apply a 100 square foot representative sample to be reviewed by the Architect and/or Owner prior to proceeding.
- H. Manufacturer shall have a minimum 10-year successful performance history of producing and installing spray-applied cellulose on similar projects.
- I. Material must be tested in accordance with ASTM E 1042 by a NVLAP accredited testing laboratory.

##### 1.04 SUBMITTALS

- A. Submit product data that the product meets or exceeds the following specified requirements.
  - 1. Bond strength shall be greater than 150 psf per ASTM E 736.
  - 2. Product shall be Class 1 Class A per ASTM E 84/ UL 723.
  - 3. Non-corrosive per ASTM C 1149
  - 4. Bond Deflection per ASTM E 759: 6" Deflection in 10' Span – No Spalling or Delamination.
  - 5. R-Value to be 3.70 per inch per ASTM C 518.
  - 6. Comply with 2015 IBC Section 803.12 stability requirements for interior finishes.
  - 7. Meet ASTM C 1149
  - 8. Product must have a publicly available Health Product Declaration (HPD) to 100 PPM

9. Product must have a third-party verified, publicly available, product-specific Environmental Product Declaration per ISO 14025
10. Manufacturer's written certification that product contains no asbestos, fiberglass or other man-made mineral fibers.
11. Copy of manufacturer's ISO 9001:2015 Certification.
12. Minimum Fiber Recycled Content to be 80%.
13. Cannot contain any added Urea-Formaldehyde Resins.

## **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Deliver in original, unopened containers bearing name of manufacturer, product identification and reference to U.L. testing.
- B. Store materials dry, off ground, and under cover.
- C. Protect liquid adhesive from freezing.
- D. Water to be potable.

## **PART 2 PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. International Cellulose Corporation 12315 Robin Boulevard  
Houston, Texas 77045  
Phone: (713) 433-6701 or (800) 444-1252  
Website: [www.spray-on.com](http://www.spray-on.com) Email: [icc@spray-on.com](mailto:icc@spray-on.com)
- B. For approved applicators contact ICC at (800) 444-1252.

### **2.02 MATERIALS**

- A. K-13 Spray-On-Systems.
  1. Color shall be from Manufacturer's standard color chart or custom color as noted
  2. Each bag must be labeled with appropriate UL classification and FM markings
  3. Each drum of adhesive must be labeled "SK-2000 adhesive to be used with K-13"

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine surfaces and report unsatisfactory conditions in writing. Do not proceed until unsatisfactory conditions are corrected.
- B. Verify surfaces to receive spray insulation to determine if priming/sealing is required to insure bonding and/or to prevent discoloration caused by migratory stains.

### **3.02 PREPARATION**

- A. Provide masking, drop cloths or other satisfactory coverings for materials/surfaces that are not to receive insulation to protect from over-spray.
- B. Coordinate installation of the sprayed cellulose fiber with work of other trades.

- C. Prime surfaces as required by manufacturer's instructions or as determined by examination.
- D. Prime all gypsum board surfaces with high quality, commercial, gypsum board primer.

### **3.03 INSTALLATION**

- A. Install spray applied insulation according to manufacturer's recommendations.
- B. Comply with local Building Code requirements.
- C. Install spray applied insulation to achieve an average R-Value of 14.80
- D. Cure insulation with continuous natural or mechanical ventilation.
  - 1. Continuous ventilation must be maintained until the material has properly cured.
- E. Remove and dispose of over-spray.

### **3.04 PROTECTION**

- A. Protect finished installation under provision of Division 1.

**END OF SECTION**

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**ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Fully adhered ethylene-propylene-diene-monomer (EPDM) covering of backwash tank.

**1.03 DEFINITIONS**

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments.

**1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
  - 1. Submit evidence of complying with performance requirements.
- C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Sample Warranties: For manufacturer's special warranties.

**1.06 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For roofing system to include in maintenance manuals.

**1.07 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: A qualified manufacturer that is FM Global approved for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

## **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

## **1.09 FIELD CONDITIONS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

## **1.10 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 20 years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Source Limitations: Obtain components including roof insulation, fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

### **2.02 PERFORMANCE REQUIREMENTS**

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
  - 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
  - 2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

### **2.03 EPDM ROOFING**

- A. EPDM: ASTM D 4637, Type I, nonreinforced, uniform, flexible EPDM sheet.
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers include:
    - a. Carlisle SynTec Incorporated
    - b. Firestone Building Products.
    - c. GenFlex Roofing Systems.
    - d. International Diamond Systems.

- e. Johns Manville; a Berkshire Hathaway company.
  - f. Lexcan Limited.
  - g. Mule-Hide Products Co., Inc.
  - h. Roofing Products International, Inc.
  - i. Versico Roofing Systems.
- B. Thickness: 60 mils (1.5 mm), nominal.
- C. Exposed Face Color: Black.

## **2.04 AUXILIARY ROOFING MATERIALS**

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
  2. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.
- B. Bonding Adhesive: Manufacturer's standard.
- C. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film.
- D. Lap Sealant: Manufacturer's standard, single-component sealant.
- E. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
1. Verify that roof openings and penetrations are in place, curbs are set and braced.
  2. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
  3. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
  4. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

### **3.03 ROOFING INSTALLATION, GENERAL**

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.



### **3.04 ADHERED MEMBRANE ROOFING INSTALLATION**

- A. Adhere roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
- B. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
- D. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.
  - 1. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.
- E. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

### **3.05 BASE FLASHING INSTALLATION**

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### **3.06 INSPECTION**

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

### **3.07 PROTECTING AND CLEANING**

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

**END OF SECTION**

## SECTION 07 54 00

### THERMOPLASTIC MEMBRANE ROOFING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide complete thermoplastic single-ply waterproofing membrane system.
  - 1. Roofing membrane:
    - a. TPO.
    - b. Fleece-backed.
  - 2. Water barrier membrane.
  - 3. Roofing insulation:
    - a. Polyisocyanurate.
  - 4. Single-ply membrane roof accessories including, but not limited to:
    - a. Membrane Walkway.
    - b. Protective Mat.
    - c. Pipe seals.
    - d. Adhesives, Tapes, and Sealants.
    - e. Flashing.
- B. Related Sections:
  - 1. Section 03 41 00 - Plant-Precast Structural Concrete
  - 2. Section 06 10 53 - Miscellaneous Rough Carpentry
  - 3. Section 07 62 00 - Sheet Metal Flashing and Trim
  - 4. Section 07 92 00 - Joint Sealants

##### 1.02 REFERENCES

- A. ASTM:
  - 1. C1177 - Glass Mat Gypsum Substrate
  - 2. C1289 - Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
  - 3. D41 - Asphalt Primer for Roofing Dampproofing & Waterproofing
  - 4. D312 - Asphalt Used in Roofing
  - 5. D412 - Vulcanized Rubber and Thermoplastic Elastomers
  - 6. D471 - Test for Effect of Liquids on Rubber
  - 7. D573 - Internal Reflection Spectroscopy
  - 8. D624 - Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
  - 9. D751 - Coated Fabrics
  - 10. D1204 - Stretching at Elevated Temps
  - 11. D2136 - Low Temp Bend Test
  - 12. D2137 - Brittleness Point of Plastics and Elastomers
  - 13. D4397 - Standards for Poly Sheeting
  - 14. D5036 - Standard Practice for Application of PVC Sheet Roofing
  - 15. D1149 - Rubber Deterioration - Surface Ozone Cracking
  - 16. D4263 - Test for Moisture in Concrete - Plastic Sheet Method
  - 17. E408 - Test for Emittance of Surfaces
  - 18. E1980 - Calculation of Solar Reflectance
- B. ASHRAE 90.1 - Energy and Atmosphere
- C. Factory Mutual Global:
  - 1. FMG Loss Prevention Data Sheet 1-28
  - 2. FMG 4450 and 4470, Membrane Roofing System Approval Guide
- D. Underwriters Laboratories, Inc. - Class A Fire Rating

### 1.03 DEFINITIONS

- A. TPO: Thermoplastic Polyolefin.
- B. Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing System," before multiplication by a safety factor.

### 1.04 SYSTEM DESCRIPTION

- A. Performance Requirements:
  - 1. Provide installed roofing membrane and base flashings that remain watertight and resist exposure to weather without failure.
  - 2. Provide roofing materials that are compatible with one another under conditions of service and application required, as approved by roofing manufacturer.
  - 3. Low Slopped Roofs: Design to resist uplift pressure calculated according to ANSI/SPRI ES 1.
  - 4. Meet IBC code requirements adopted by state in which project is located.
  - 5. Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system, and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
  - 6. Meet Factory Mutual I-90 rating.
  - 7. Meet Factory Mutual designation for hail resistance SH
- B. Environmental Requirements:
  - 1. EPA Energy Star ratings.

### 1.05 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, maintenance recommendations, and copy of warranty.
- C. Shop Drawings: Submit Shop Drawings showing system fabrication; installation drawings; roof insulation plans indicating layout, slopes, average R-value, base flashings and membrane terminations; fastening patterns; roof seaming plan; details of components, within system and between system and adjoining system.
- D. Component Samples: Submit manufacturer's standard components, including water barrier membrane, roof insulation, membrane, membrane flashings, securement devices, walkway pads or rolls, pavers, and ballast, if any, with Product Data and Shop Drawings.
- E. Quality Assurance/Control Submittals:
  - 1. Reports: Manufacturer's representative written observation reports.
  - 2. Maintenance and care instructions for O&M Manuals.

### 1.06 QUALITY ASSURANCE

- A. Single Source Responsibility:
  - 1. Obtain primary flexible sheet roofing from a single manufacturer.
  - 2. Provide secondary materials as recommended by manufacturer of primary materials.
- B. Qualifications:
  - 1. Manufacturer:
    - a. 10 years' experience in the manufacture of thermoplastic membrane roofing.
  - 2. Contractor: 3 years' experience in the installation of thermoplastic membrane roofing.

3. Personnel: For actual installation of membrane roofing, use personnel skilled in Work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of Work.
- C. Certifications: Provide to Engineer, certification of installer from manufacturer of thermoplastic membrane roofing.
- D. Manufacturer's Observation:
  1. Manufacturer's agent shall visit site while roofing work is in progress as necessary, including final inspection for warranty requirements, to observe procedures and methods, keep log of time, instructions given, actual procedures, field conditions, etc.
  2. Submit 2 copies of report to Engineer.
- E. Preinstallation Meeting: Installer and manufacturer's technical representative shall meet, as well as installers whose work interfaces with or affects roofing, prior to the start of installation.
- F. Notification: Notify Engineer at least 24 hours before performing seaming operations.

## **1.07 PROJECT CONDITIONS**

- A. Weather: Proceed when existing and forecasted weather conditions permit Work to be performed in accordance with manufacturer's recommendations and warranty requirements.
- B. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## **1.08 WARRANTY**

- A. Manufacturer's Warranty: Provide 20-year non-prorated manufacturer's total system warranty including repair or replacement, materials and labor at no cost to Owner. Failure includes roof leaks.
- B. Contractor's Maintenance Warranty:
  1. During a period of 5 years from the date of final acceptance of the Work, maintain the roof system, including wood blocking, water barrier membrane, insulation, roof membrane, and flashing, in a watertight condition, and repair all defects which result from faulty workmanship or defective materials, without further cost to the Owner, including replacement of any wet insulation caused by such defects.
  2. Excluded from this warranty:
    - a. Damage to roof, buildings and contents caused by acts or omissions of the Owner.
    - b. Fire, lightning, winds of peak gust speeds of 90 mph or higher measured at 10 meters above the ground, hailstorm, or other unusual phenomenon of the elements.
    - c. Movement or failure of the supporting building structure that causes membrane or flashing failure.
    - d. Vapor condensation beneath the roof.
  3. Before expiration of the warranty period, inspect the roof in the presence of the Owner and make necessary correction of deficiencies.
  4. The warranty shall remain in force until necessary repair work has been done.
  5. Use form at end of this Section for 5-year Contractor's Warranty.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. TPO Membrane Roofing System:
  1. Standard of Quality: Design is based on products of Carlisle Syn Tec Inc. [www.carlisle-syntec.com](http://www.carlisle-syntec.com)

2. Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
  - a. GAF Materials Corporation, Wayne, NJ [www.gaf.com](http://www.gaf.com)
  - b. Firestone Building Products Company, Carmel, IN [www.firestonebpc.com](http://www.firestonebpc.com)
  - c. GenFlex Roofing Systems [www.genflex.com](http://www.genflex.com) Johns Manville International, Inc. [www.jm.com](http://www.jm.com)
  - d. Sarnafil, Inc. [www.sarnafil.com](http://www.sarnafil.com)
  - e. Versico Inc., Akron, OH [www.versico.com](http://www.versico.com)
  - f. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
  
- B. Insulation: Acceptable Manufacturers: Subject to compliance with requirements and acceptance by membrane manufacturer, acceptable manufacturers and products are:
  1. Polyisocyanurate:
    - a. *Hy-Therm Spas* by Dow Chemical Company, Midland, MI [www.dow.com/styrofoam](http://www.dow.com/styrofoam)
    - b. *ISO 95+* by Firestone Building Products, Carmel, IN [www.firestonebpc.com](http://www.firestonebpc.com)
    - c. *Energygard* by GAF Materials Corporation, Wayne, NH [www.gaf.com](http://www.gaf.com)
    - d. *HP-H* by Carlisle Syntec [www.carlisle-syntec.com](http://www.carlisle-syntec.com)
    - e. *NRG* by Johns Manville Roofing systems Group, Denver, CO [www.jm.com](http://www.jm.com)
    - f. R-Max, Inc., Dallas TX [www.rmaxinc.com](http://www.rmaxinc.com)
    - g. Versico ISO, Akron, OH [www.versico.com](http://www.versico.com)
    - h. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
  
- C. Roof Accessories:
  1. Accessories for membrane system to be provided by or approved by membrane manufacturer.
  2. Adhesive systems for attaching insulation board directly to decking.
    - a. Polyurethane:
      - 1) *Insta-Stik*, Dow Chemical, Marietta GA [www.flexibleproducts.com](http://www.flexibleproducts.com)
    - b. Elastomeric:
      - 1) *Weather-Tite*, Millennium Adhesive Products, Chagrin Falls, OH
      - 2) *Olybond 500* by Olympic

## 2.02 TPO ROOFING SYSTEM MATERIALS

- A. Reinforced TPO:
  1. Uniform, flexible, fleecebacked membrane.
  2. Thickness: 60 mils.
  3. Exposed Face Color: Rock Brown.
  4. Physical Properties:
    - a. Breaking strength: 1500 psi, machine direction; 1300 psi cross-machine direction; ASTM D412.
    - b. Ultimate elongation: 500 percent ASTM D412.
    - c. Tensile set: 15 percent, maximum; ASTM D412.
    - d. Tearing strength: 340 pound/foot per inch; ASTM D624.
    - e. Brittleness point: Minus 22 degrees F.
    - f. Ozone resistance: 166 hours at 104 degrees F, wrapped around 3-inch-diameter mandrel: No cracks
    - g. Resistance to heat aging: 90 percent minimum retention of breaking strength, elongation at break, and tearing strength after 166 hours at 240 degrees F; ASTM D573.
    - h. Water absorption: Less than 4 percent mass change after 166 hours immersion at 158 degrees F; ASTM D471.
    - i. Linear dimension change: Plus or minus 2 percent: ASTM D1204.
  5. Product: *EverGuard 60* by GAF.

## 2.03 WATER BARRIER MEMBRANE SYSTEM

- A. Cold-applied Self-adhering Membrane:
  1. Comply with ASTM D4397.
  2. 10 mil polyethylene.

## 2.04 ROOF INSULATION

- A. Insulation system shall have a minimum average R-value = 30 at 75 degrees F
- B. Provide minimum of 2 layers base insulation, staggered in each direction.
- C. Provide factory-tapered insulation fabricated to slope indicated on Drawings.
- D. Minimum Thickness: (2) layers of 2-inch all locations, 4-inches total minimum.
- E. Polyisocyanurate Insulation:
  - 1. Meet ASTM C1289.
  - 2. Maximum 4 foot by 4-foot boards.
  - 3. All packages to have RIC/TIMA label.
  - 4. Minimum 2 layers. Taper top layers where indicated on Drawings **OR** Contractor has option to substitute tapered isocyanurate insulation for tapered expanded polystyrene insulation.
- F. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

## 2.05 ROOFING ACCESSORIES

- A. Protective Mat:
  - 1. Woven or nonwoven polypropylene, polyolefin, or polyester fabric mat.
  - 2. Resistant to ultraviolet degradation.
  - 3. Chemically resistant.
  - 4. Type and weight as recommended by roofing system manufacturer.
- B. Membrane Walkway:
  - 1. 1/8" thick extruded and embossed TPO roll , heat welded directly to roofing membrane with traction surface.
- C. Control Joint Tube: Schuller Expand-O-Flash or approved equal.
- D. Adhesives and Sealants:
  - 1. Splicing cement, lap sealant, bonding adhesive, water cutoff mastic, as recommended by membrane manufacturer.
  - 2. Adhesives for insulation directly to roof decks, other insulation boards, and smooth built-up roof surfaces (non-graveled), where mechanical fastening is not acceptable:
- E. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8-inch thick, with anchors.
- F. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.
- G. Fasteners:
  - 1. Factory Mutual and membrane manufacturer approved.
  - 2. Membrane Attachment:
    - a. As recommended and supplied by membrane manufacturer.
    - b. Length to penetrate 1-1/2-inch wood deck minimum of 1 inch, but not through bottom of deck.
    - c. Length to penetrate through plywood deck minimum 3/4-inch.
  - 3. Flashing to Lumber: Galvanized 1-1/2-inch barbed roofing nails through 1-inch metal discs.
  - 4. Scupper flanges to wood blocking: 1-3/4-inch galvanized roofing nails.
  - 5. Metal Decks: Deckfast *Sentry* corrosion resistant fastener.
  - 6. Concrete Decks: *Gripcon* nail, by Reach Plastics.
- H. Flashing:
  - 1. As recommended by membrane manufacturer, with associated adhesives.

- I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

## **PART 3 EXECUTION**

### **3.01 SURFACE CONDITIONS**

- A. Verify:
  - 1. Roof deck is completely installed.
  - 2. Surface is free of debris, sharp projections, gross irregularities, unnecessary holes.
  - 3. Required openings through deck are cut and finished, and pipes and similar work projecting through deck are in place.
  - 4. Concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method, in accordance to ASTM D4263.
  - 5. Substrates have been inspected and are determined to be in satisfactory condition and meet all membrane adherence requirements for roofing warranty.
- B. Do not proceed until conditions which would result in an unsatisfactory installation are corrected.
  - 1. Discrepancies: Immediately notify Engineer.
  - 2. Commencing work shall be construed as acceptance of roof deck and adjoining surfaces as acceptable to receive membrane sheet roofing.
- C. Field Dimensions: Drawings do not purport to show actual dimensions, but are intended only to establish location and scope of Work. Field verify dimensions and assume full responsibility for their accuracy.
- D. Compatibility: Verify that membranes and flashings are chemically compatible with nailers and blocking.

### **3.02 PREPARATION**

- A. Review structural loading limitations of roof deck during and after roofing.
- B. Coordination:
  - 1. Coordinate with other trades so other work available and roofing can be built in without delay.
  - 2. Plan work so work can be carried on continuously to completion.
  - 3. Coordinate application of membrane to provide protection of underlying materials from wetting or other damage by the elements on a continuous basis.
- C. Do not install more insulation than what can be covered by membrane before the end of the workday.
- D. Completely install sheet metal sleeves, caps, or enclosures on a daily basis.
- E. Reset or replace existing fasteners for materials exposed but left in place that are loose, deformed, damaged, or corroded.
- F. Fill insulation joints wider than 1/4 inch with insulation cut to fit.
- G. Back out existing screws from deck.
- H. Prevent materials from entering and clogging roof drains and conductors, and from spilling or migrating onto surfaces of other construction.
- I. Remove roof-drain plugs when no work is taking place or when rain is forecast.

- J. Perimeter wood blocking, insulation, and sheet metal installation shall be in accordance with recommendations of Factory Mutual Loss Prevention Data Sheet 1-49, June 1985 (minimum).

### **3.03 INSULATION**

- A. General:
  - 1. Lay with long dimension perpendicular to precast joints.
  - 2. Cut, fit neatly against wood blocking and vertical surfaces.
  - 3. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
  - 4. Fill voids greater than 1/8 inch with foamed-in-place insulation compatible with rigid material.
  - 5. Install tapered insulation to drain to scuppers.
  - 6. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
  - 7. Stagger insulation boards 50 percent from row to row.
- B. Fully Adhered Roofing Insulation: Mechanically fasten insulation with specified fasteners in a Factory Mutual approved pattern.
- C. Drainage slope: Taper as indicated on Drawings.
- D. Layers:
  - 1. Place in at least 2 layers.
  - 2. Stagger joints in both directions in adjoining courses, stagger end joints between layers at least 24 inches.
  - 3. Butt each panel tightly to adjoining panels, but do not force.
- E. Protection:
  - 1. Keep insulation dry.
  - 2. Protect from damage after installation.
  - 3. Lay no more insulation than can be covered with completed roof membrane on same day.
  - 4. Protect exposed edges of insulation with water cut offs at end of each day's work.
  - 5. Remove water cut offs completely before resuming work.

### **3.04 ROOFING MEMBRANE INSTALLATION**

- A. Perform work in strict conformance with applicable provisions of manufacturer's current published specifications, application instructions, recommended details, and standards of practice.
- B. Install according to manufacturer's written instructions and ASTM D5036.
- C. Install in presence of roofing membrane manufacturer's personnel.
- D. Accurately align roofing membrane without stretching and maintain uniform side and end laps of minimum dimensions required by manufacturer.
- E. Stagger end laps.

### **3.05 ADHERED ROOFING INSTALLATION**

- A. Bonding Adhesive:
  - 1. Solvent-based:
    - a. Apply to substrate and underside of membrane as required by manufacturer.
    - b. Allow to partially dry.
    - c. Do not apply to splice area of membrane.
  - 2. Water-based:
    - a. Apply as required by manufacturer and immediately install roofing membrane.
    - b. Do not apply adhesive to splice area of roofing membrane.



- B. Fasten or adhere membrane securely at terminations, penetrations, and perimeter of roofing, according to ANSI/SPRI RP-4.
- C. Shingle side laps with slope of roof deck where possible.
- D. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

### **3.06 SEAMS**

- A. Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps according to manufacturer's instructions to ensure a watertight seam.
- B. Test lap edges with probe to verify seam weld continuity.
- C. Apply lap sealant to seal cut edges of membrane.
- D. Verify field strength of seams with tack claw and repair seam sample areas.
- E. Repair deficiencies.

### **3.07 WATER BARRIER MEMBRANE SYSTEM**

- A. Seal joints with tape or sealant.
- B. Repair punctures before installing insulation.
- C. Apply only in fair weather when air, substrate, and membrane are at temperatures of 40 degrees or higher. Surfacing materials must also be placed at temperatures of 40 degrees or higher.
  - 1. For application in temperatures below 40 degrees, store materials in a heated storage area, in a manner that does not pose a fire hazard, when ambient temperatures fall below 40 degrees.
  - 2. Do not remove material from storage areas until ready to install.
- D. Start at the low point of the roof area and progress upslope, running the membrane perpendicular to the slope in shingle fashion so there are no laps against the flow of water.
- E. Peel back 1 to 2 feet of release paper, align the membrane, and place the first 1 to 2 feet.
- F. Roll laps firmly with a hand roller and lap ends and edges a minimum of 6 inches.
- G. Totally envelope roof insulation and seal to underside of membrane roofing.
- H. Repair fishmouths.

### **3.08 ROOF ACCESSORIES**

- A. Base Flashing:
  - 1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
  - 2. Apply solvent-based bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
  - 3. Flash penetrations and field-formed inside and outside corners with sheet flashing.
  - 4. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.
  - 5. Terminate and seal top of sheet flashings.

### **3.09 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner may engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Engineer.
  - 1. Notify Engineer or Owner 48 hours in advance of date and time of inspection.
- C. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### **3.10 PROTECTION AND CLEANING**

- A. Site Cleaning:
  - 1. Do not allow accumulation of scraps, debris arising from work of this section.
  - 2. Maintain premises in neat, orderly condition.
  - 3. Immediately upon satisfactory completion of work, remove debris, equipment, excess materials from Site.
- B. System Cleaning:
  - 1. Prevent misplacing roofing materials and adhesives on adjacent surfaces.
  - 2. Immediately remove traces of such materials.
- C. Protect completed roof system from damage.
  - 1. Use plywood walkways, wood planking, other precautions as necessary.
  - 2. Institute appropriate procedures for surveillance and protection of roofing during remainder of construction period.
  - 3. Confine traffic over roof to necessary areas, hold to minimum.
  - 4. Repair damage immediately.
- D. When construction completed and roofing no longer at risk of construction damage, remove temporary protective measures, reinstall ballast to satisfaction of Owner and manufacturer of existing roofing.

### **3.11 DEMONSTRATION**

- A. Maintenance Instructions: Manufacturer's representative (not installer) to schedule and attend meeting with Owner's representatives to explain:
  - 1. Maintenance and Care Instructions.
  - 2. Recommended Maintenance Program.
  - 3. Warranty Requirements.

**END OF SECTION**

## ROOFING WARRANTY

Project: \_\_\_\_\_

Project Address: \_\_\_\_\_

Project No: \_\_\_\_\_

Date of Final Acceptance: \_\_\_\_\_

Owner: \_\_\_\_\_

Address: \_\_\_\_\_

Roofing Contractor: \_\_\_\_\_

Address: \_\_\_\_\_

Phone No: \_\_\_\_\_

This warranty stipulates that the above-named contractor(s) shall, during a period of 5 years from the date of final acceptance of the work, maintain the roof membrane and flashing systems in a watertight condition and repair all defects which result from faulty workmanship or defective materials, without further cost to the Owner, including replacement of any wet insulation caused by such defects.

Excluded from this warranty may be any and all damage to said roof, the building(s) or their contents, caused by acts or omissions of the Owner; fire, lightning, winds of peak gust speeds of 90 mph or higher, hailstorm, or other unusual phenomenon of the elements; movement or failure of the supporting building structure that causes flashing failure; or vapor condensation beneath the roof.

Exclude from this warranty any damages to the building(s) or the contents.

Before expiration of the above warranty period, the roofing contractor shall inspect the roof in the presence of the Owner's representative and make necessary correction of all deficiencies not considered normal. The warranty shall remain in force until the necessary repair work has been completed.

### ROOFING CONTRACTOR

Signed: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

## SECTION 07 62 00

### SHEET METAL FLASHING AND TRIM

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide sheet metal flashing and trim for:
  - 1. Prefinished roof coping system.
  - 2. Roof Drainage System.
  - 3. Roof flashing and accessories.
  - 4. Sheet metal accessories including, but not limited to:
    - a. Water barrier membrane.
    - b. Fasteners.
    - c. Splashblocks.
- B. The following is not included in this section:
  - 1. Joint Sealants (Section 07 92 00).
- C. Related Sections:
  - 1. Section 03 41 00 - Plant-Precast Structural Concrete
  - 2. Section 06 10 53 - Miscellaneous Rough Carpentry
  - 3. Section 07 54 00 - Thermoplastic Membrane Roofing
  - 4. Section 07 92 00 - Joint Sealants

##### 1.02 REFERENCES

- A. ASTM:
  - 1. A167 - Stainless and Heat Resistant Chromium Nickel Steel Plate, Sheet
  - 2. A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Coated (Galvannealed) by the Hot-Dip Process
  - 3. A853 - Steel Wire, Carbon
  - 4. B32 - Specifications for Solder Metal
  - 5. B101 - Lead Coated Copper Sheet and Strip
  - 6. B209 - Aluminum Sheet and Plate
  - 7. B370 - Copper Sheet and Strip
  - 8. C920 - Elastomeric Joint Sealants
  - 9. D522 - Mandrel Test for Organic Coatings, Formability
  - 10. D1970 - Self-Adhering Polymer Modified Bituminous Sheet Materials
  - 11. D2244 - Color Tolerances
  - 12. D2794 - Impact Resistance
  - 13. D4214 - Evaluation of Degree of Chalking
  - 14. E111 - Modulus Testing, Elasticity
  - 15. E228 - Test for Thermal Expansion
  - 16. G90 - Performing Accelerated Weathering of Non-Metallic Materials
- B. SMACNA: *Architectural Sheet Metal Manual*

##### 1.03 SYSTEM DESCRIPTION

- A. Design Requirements: Provide watertight metal copings on entire roof perimeter. Provide other flashings as per Details shown in the Drawings.
- B. Performance Requirements:
  - 1. Sheet metal flashing and trim shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

2. Low Sloped Roofs: Design to resist uplift pressure calculated according to ANSI/SPRI ES 1.

#### **1.04 SUBMITTALS**

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.
- C. Shop Drawings: Include layout, profiles, methods of joining, and anchorage details.
- D. Samples:
  1. Color: Submit manufacturer's standard color samples with Product Data and Shop Drawings.
  2. Samples of sheet metal flashing, trim, and accessory items in specified finish, showing full range of variations expected.

#### **1.05 QUALITY ASSURANCE**

- A. Single Source Responsibility: Provide sheet metal flashing and trim units made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
- B. Qualifications:
  1. Manufacturer: 5 years' experience in the manufacture of sheet metal flashing and trim.
  2. Contractor: 3 years' experience in the installation of sheet metal flashing and trim.
  3. Personnel: For actual installation of sheet metal flashing and trim, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.
- C. Regulatory Agencies:
  1. Meet UL requirements for fire resistance of roof covering materials and impact resistance.
  2. Meet wind/uplift resistance of ANSI/SPRI ES 1 per IBC.

#### **1.06 PROJECT CONDITIONS**

- A. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

#### **1.07 WARRANTIES**

- A. Manufacturer: Non-prorated 20-year written warranty covering fade, chalking and film integrity including labor and material through the 20th year.
- B. Contractor:
  1. Sheet metal system and related flashing shall be warranted in writing stipulating that Contractor agrees to maintain metal flashing system in a watertight condition for a period of 5 years at the Contractor's own expense.
  2. Warranty shall cover any condition caused by defective material and the installation and ordinary wear and tear.
  3. Warranty does not cover damage due to natural disaster not covered by insurance, accidents, misuse or vandalism.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURER**

- A. Manufactured Products:
  1. Standard of Quality: Design is based on W.P. Hickman Company, Asheville, NC [www.wph.com](http://www.wph.com)

2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Metal Era, Inc, Waukesha WI, [www.metalera.com](http://www.metalera.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- B. Prefinished Metal for Fabricated products:
1. Standard of Quality: Design is based on PacClad, Elk Grove Village, IL [www.pac-clad.com](http://www.pac-clad.com)
  2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Berridge Manufacturing, Houston, TX [www.berridge.com](http://www.berridge.com)
    - b. *UnaClad*, Firestone Metal Products [www.unaclad.com](http://www.unaclad.com)
    - c. W.P. Hickman Company, Asheville, NC [www.wph.com](http://www.wph.com)
    - d. *ColorKlad* by Ryerson, Minneapolis, MN [www.ryerson.com](http://www.ryerson.com)
    - e. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- C. Water Barrier Membrane: Standard of Quality: Design is based on CCW WIP 300HT by Carlisle Coatings and Waterproofing [www.carlisle-ccw.com](http://www.carlisle-ccw.com)
1. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. *Ice and Water Shield*, Grace Company [www.grace.com](http://www.grace.com)
    - b. *Winterguard*, CertainTeed, Valley Forge, PA [www.certainteed.com](http://www.certainteed.com)
    - c. Polyguard Inc., Ennis, TX [www.polyguardproducts.com](http://www.polyguardproducts.com)
    - d. *Rainproof TM* by Protecto Wrap Co., Denver, CO [www.protectowrap.com](http://www.protectowrap.com)
    - e. *Deck Guard* by Polyguard Products, Ennis, TX [www.polyguardproducts.com](http://www.polyguardproducts.com)
    - f. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Sheet Metal:
1. Verify recycled content from manufacturer.
  2. Performance Requirements:
    - a. Color Change: ASTM D2244, Not greater than 5 NBS color units.
    - b. Chalking: 8 or better, ASTM D4214.
    - c. Minimum yield: ASTM A853.
    - d. Formability: ASTM D522.
    - e. M.O.E.: ASTM E111.
    - f. COTE: ASTM E228.
    - g. Impact resistance: ASTM D2794, 70 inch/pound, no tape pick-off.
  3. Galvanized Steel:
    - a. Standard open hearth copper bearing steel with "Paint-Grip" galvanized coating.
    - b. 24 gage minimum. For use as keepers or when otherwise covered.
    - c. Pre-painted sheets of hot-dipped galvanized steel of commercial weight and quality, ASTM A653, G90.
    - d. Painted side shall be covered with a factory applied strippable film.
    - e. Apply washcoat of 0.3 to 0.4 mil dry film thickness to unpainted side.
    - f. Gages: As indicated on Drawings. Where not indicated, minimum gages:
      - 1) Facias, coping, and other roof edge flashing exposed view with an exposed vertical face of 8 inch or less: 24 gage.
      - 2) Hook strips and keepers: 24 gage.
      - 3) Gutter hangers and downspout straps: 16 gage.
      - 4) All other sheet metal work: 24 gage.
  4. Stainless Steel: ASTM A167, AISI 302/304, No. 2D finish, temper as required for forming and performance; 0.015 inch thick (28 gage), except as otherwise indicated.

## 2.03 SHEET METAL ACCESSORIES

- A. Nails and Fasteners:
1. Galvanized nails and cadmium-plated screws and washers in connection with galvanized iron and steel, which will not stain, produce electrolytic reaction or be detrimental to complete installation.

2. Same metal as sheet metal flashing or recommended by sheet metal manufacturer. Avoid non-compatible or dissimilar metals due to risk of galvanic corrosion.
  3. Match finish of exposed heads with material being fastened.
- B. Solder: ASTM B32.
1. Copper: Grade Sn50, 50 percent lead, 50 percent tin solder, commercial soldering flux.
  2. Lead-coated copper: Grade Sn60, 60 percent in and 40 percent lead.
  3. Stainless steel: Grade Sn60 with acid flux of type recommended by stainless steel sheet manufacturer.
  4. Zinc: 60 percent lead and 40 percent tin with low antimony.
- C. Joint Sealant: Elastomeric 20-year silicone, per ASTM C920, Type S, Grade NS, Class 50.
- D. Adhesives: Recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.
- E. Other Materials: Other materials not specifically described but required for complete, proper installation of sheet metal and flashing, subject to acceptance of Engineer.

## 2.04 MANUFACTURED PRODUCTS

- A. Prefinished Roof Coping System
1. Prefinished Cap Flashing:
    - a. 24-gage galvanized.
    - b. Concealed joint covers.
    - c. Metal drain support chairs, same color and finish as coping cap.
    - d. 20 gage galvanized steel cleats.
    - e. 20-year, 110 mph wind warranty.
    - f. FM 1-90 approved for wind uplift.
    - g. Finish: Prefinished Kynar
    - h. Product: Perma-Tite, configurations as shown in Drawings.
- B. Roof Drainage System:
1. Scuppers and Conductors:
    - a. 24-gage galvanized.
    - b. Hemmed or fully welded joints.
    - c. 20 gage galvanized steel cleats.
    - d. Finish: Prefinished Kynar
    - e. Fabricate similar to Drawings using any applicable industry standards and conforming to SMACNA guidelines.
  2. Downspouts:
    - a. 24-gage galvanized.
    - b. Open Face.
    - c. Factory starter tube.
    - d. Factory straps.
    - e. Closed profile factory elbows at gutter to wall transition.
    - f. Factory elbow at base to direct water away from wall and onto splash blocks unless noted otherwise.
    - g. Size per Roof Drain Manufacturers Association Recommendations.
    - h. Kynar finish.
    - i. Product: Hickman Downspouts.
  3. Gutters:
    - a. 24-gage galvanized.
    - b. Profile to match existing.
    - c. Factory straps, end caps, joint fasteners and downspout strainers.
    - d. Kynar finish.
    - e. Product: Hickman Gutters.
  4. Splash Blocks: Precast concrete type of size and profiles indicated; minimum 3,000 psi (21 MPa) at 28 days, with minimum 5 percent air entrainment.

5. Gutter Screen: 1/4-inch hardware cloth installed in sheet metal frames. Use same material as gutters and downspouts.
- C. Reglet Flashing:
1. Reglet Flashing: Two-piece Surface-mounted at poured in place concrete.
    - a. Factory-mitered and welded corners and junctions.
    - b. Reglet and matching counterflashing.
    - c. Prefinished metal - Kynar.
    - d. Post finished Kynar where required by manufacturer for radius applications.
    - e. Product: Drive-Lock To-Wall Counterflashing.

## 2.05 WATER BARRIER MEMBRANE

- A. Cold-applied Self-adhering Membrane:
1. High-strength polyethylene film coated on 1 side with a thick layer of adhesive consistency rubberized asphalt.
  2. Membrane to be able to withstand temperature of 200 degrees F without adhesive degradation.
  3. ASTM D1970.
  4. Thickness: 0.004 inch.
  5. Provide complete with manufacturer's recommended primer.

## 2.06 FABRICATION

- A. General Requirements:
1. Comply with SMACNA's "Architectural Sheet Metal Manual."
  2. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  3. Fabricate with strippable film in place.
  4. Accurately form with brakes, straight, true, and sharp; plain surfaces free from warps and buckles and tool marks.
  5. Fabricate nonmoving seams with flat-lock seams. Where joint movement is necessary, provide 1-inch-deep interlocking hooked flanges, filled with mastic sealant.
  6. Tin edges to be seamed, form seams, and solder.
  7. Match profiles exactly at connections.
  8. Exposed edges to be beaded or returned for strength and appearance.
  9. Allow for expansion and contraction.
- B. Reinforcement: Provide ribs, cleats, and reinforcement necessary to make sections rigid and substantial.
- C. Seams, Joints:
1. Locate joints of roof edges, other sheet metal work exposed to view with respect to other architectural features as indicated on Drawings or as directed by Engineer.
  2. Overlap in direction of flow.
  3. Use concealed cover plates.
  4. Where appearance is not a factor, fabricate in 8 or 10-foot lengths.
  5. Design field joints to permit expansion.
  6. Use joint covers or lapped joints with "s" clips; do not solder.
  7. Locate field joints at least 12 inches, no more than 3 feet, from actual corner.
  8. Provide 4-inch-wide flanges for setting on built-up asphalt roofing system membrane with concealment by composition stripping.
  9. Fabricate gravel stops and aggregate divider strips with 1 inch high standing leg of folded sheet metal, notched from top with deep "V" notches.
- D. Penetration Sleeves: Fabricate with minimum 8-inch-high stack, of diameter 1 inch larger than penetrating element.
- E. Soldering:
1. Pre-tin edges of sheet metal to be soldered with solder on both sides, width of pre-tinning at least 1-1/2 inches.



2. Solder slowly with well-heated coppers to thoroughly heat sheets and completely sweat solder through full width of seam. Use ample solder.
3. Show at least 1 inch evenly flowed solder at seams.
4. Wherever possible solder work in flat position.
5. Solder seams with a slope greater than 45 degree a second time.

## **2.07 FINISHES**

- A. Coating System: 2-coat system of organic coating on the face side consisting of fluorocarbon base topcoat applied over quality matched primer with whitewash coat applied to back side for additional protection.
  1. Color: Match existing Dark Bronze. Verify color match and submit samples in accordance with Part 1.04
- B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades:
  1. Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
  2. Coordinate Work with interfacing and adjoining Work, for proper sequencing of each installation.
  3. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.
- B. Verification of Conditions: Verify that flashing and sheet metal may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies: Immediately notify Engineer. Do not proceed with installation in areas of discrepancy until fully resolved.

### **3.02 METAL PROTECTION**

- A. Do not place dissimilar metals in contact nor in position where drainage will occur across them.
- B. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
- C. Water Barrier Membrane:
  1. Install as recommended by manufacturer at locations indicated on Drawings.
  2. Use of primer is required.

### **3.03 INSTALLATION**

- A. General:
  1. Apply fabrication instructions of this Section to field installation.
  2. Install with strippable film in place.
  3. Install work neatly and anchor securely.
  4. Overlap seams in direction of flow and slope all horizontal surfaces for drainage.
  5. Join parts with rivets or sheet metal screws where necessary for strength or stiffness.
  6. Whenever possible, secure metal by means of clips or cleats without nailing through metal, in no case shall nails, rivets, or screws be exposed on outside of facias, copings, etc.
  7. Secure metal flashings at roof edges according to ANSI/SPRI ES 1 Loss Prevention Data Sheet 1-49 for wind zone of Project.

8. Equipment support flashing: Coordinate with roofing and equipment installation. Weld or seal flashing to equipment support member.
  9. Finished work to be water, weather tight.
- B. Expansion Provisions:
1. Provide for thermal expansion of exposed flashing and trim.
  2. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner of intersection.
  3. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.
- C. Joint Sealants: Apply wherever required to ensure watertight installation of sheet metal flashing after removing protective film.
- D. Splash Blocks: Precast Concrete Splash blocks: Contoured; 36 inches by 10-1/2 inches by 3 inches. One at each downspout except where splash pans or trench drains are required.

### **3.04 ADJUSTING**

- A. Replace or repair sheet metal flashing and trims that have been damaged or deteriorated beyond successful repair by finish touching or similar repair procedures.

### **3.05 CLEAN UP**

- A. Immediately after completing work, remove strippable film.
- B. Clean sheet metal surfaces with mild soap and water to be suitable to receive specified finishes.
- C. Remove substances that might cause corrosion of metal or deterioration of finishes.

### **3.06 PROTECTION**

- A. Provide final protection and maintain conditions to ensure flashing and trim are without damage or deterioration other than natural weathering at the time of Substantial Completion.

**END OF SECTION**

**SHEET METAL WARRANTY**

Project: \_\_\_\_\_

Project Address: \_\_\_\_\_

Project No: \_\_\_\_\_

Date of Final Acceptance: \_\_\_\_\_

Owner: \_\_\_\_\_

Address: \_\_\_\_\_

Sheet Metal Contractor: \_\_\_\_\_

Address: \_\_\_\_\_

Phone No: \_\_\_\_\_

Roofing Contractor: \_\_\_\_\_

Address: \_\_\_\_\_

This warranty stipulates that the above-named contractor(s) shall, during a period of 5 years from the date of final acceptance of the work, maintain the sheet metal flashing systems and repair all defects which result from faulty workmanship or defective materials, without further cost to the Owner, including replacement of any wet insulation caused by such defects.

Excluded from this warranty may be any and all damage to said roof, the building(s) or their contents, caused by acts or omissions of the Owner; fire, lightning, winds of peak gust speeds of 90 mph or higher, hailstorm, or other unusual phenomenon of the elements; movement or failure of the supporting building structure that causes flashing failure; or vapor condensation beneath the roof.

Exclude from this warranty any damages to the building(s) or the contents.

Before expiration of the above warranty period, the contractor(s) shall inspect the sheet metal in the presence of the Owner and make necessary correction of all deficiencies not considered normal. The warranty shall remain in force until the necessary repair work has been completed.

**SHEET METAL CONTRACTOR**

**ROOFING CONTRACTOR**

Signed: \_\_\_\_\_

Signed: \_\_\_\_\_

Title: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

Date: \_\_\_\_\_

## SECTION 07 72 33

### ROOF HATCHES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Roof hatches.
    - a. Aluminum.
  - 2. Hatch accessories.
  
- B. Related Sections:
  - 1. Section 03 41 00 - Plant-Precast Structural Concrete
  - 2. Section 06 10 00 - Rough Carpentry
  - 3. Section 06 10 53 - Miscellaneous Rough Carpentry
  - 4. Section 07 54 00 - Thermoplastic Membrane Roofing
  - 5. Section 07 62 00 - Sheet Metal Flashing and Trim
  - 6. Section 07 92 00 - Joint Sealants

##### 1.02 REFERENCES

- A. ASTM:
  - 1. A36 - Structural Steel

##### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
  
- B. Product Data: Manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance and cleaning recommendations.
  
- C. Shop Drawings: Show system fabrication, installation drawings, including plans, dimensions, profiles, details of components, locations and configurations within system and between system and adjoining system.
  
- D. Samples:
  - 1. Initial Color Selection: Submit manufacturer's standard color samples for each type of finish with Product Data and Shop Drawings.
  
- E. Maintenance Manual: Provide maintenance and warranty data in "Maintenance Manual" at Maintenance Demonstration at Substantial Completion.

##### 1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide roof specialty and accessory units made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
  
- B. Qualifications:
  - 1. Manufacturer: 5 years experience in the manufacture of roof specialties and accessories, with 6 projects of similar size, scope and type of which 3 have been in successful use for 3 years or longer.
  - 2. Contractor: 3 years experience in the installation of roof specialties and accessories.
  - 3. Personnel: For actual installation of roof specialties and accessories, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.

- C. Field Samples: If requested, furnish sample of each type of roof and floor hatches to Engineer for review at the job site prior to manufacture/installation. Install approved sample.
- D. Preinstallation Meetings: Installer and manufacturer's technical representative shall meet with Engineer prior to the start of installation.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with manufacturer's recommendations for job-site storage and protection.

#### **1.06 PROJECT CONDITIONS**

- A. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

#### **1.07 WARRANTY**

- A. 5-year non-prorated warranty against defects in material or workmanship, including installation.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURER**

- A. Roof Hatch:
  - 1. Standard of Quality: Design is based on products of Bilco Company, New Haven, CT [www.bilco.com](http://www.bilco.com)
  - 2. Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Babcock-Davis, Brooklyn Park, MN [www.babcockdavis.com](http://www.babcockdavis.com)
    - b. J.L. Industries, Bloomington, MN [www.jlindustries.com](http://www.jlindustries.com)
    - c. Nystrom, Minneapolis, [www.nystrom.com](http://www.nystrom.com)
    - d. Milcor, Inc., Lima, OH [www.milcorinc.com](http://www.milcorinc.com)
    - e. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

#### **2.02 FABRICATION**

- A. Roof Hatches:
  - 1. Size and Model: 36-inch by 30-inch (Type S).
  - 2. Construction: Single leaf, pre-assembled by manufacturer.
  - 3. Curb:
    - a. 11-gage aluminum.
    - b. 12-inch-high curb with 3-1/2-inch-wide flange.
    - c. Include holes for securing to roof deck and integral counter flashing.
    - d. Equip with integral metal cap flashing of same gage and material as curb, fully welded at corners.
  - 4. Cover:
    - a. 11-gage aluminum.
    - b. 3-inch beaded flange with formed reinforcing members.
    - c. Seal: Heavy extruded EPDM/Neoprene rubber gasket bonded to cover interior to ensure continuous seal when compressed to top surface of curb.
  - 5. Liner: 18-gage aluminum.
  - 6. Finish:
    - a. Galvanized steel: Prime with alkyd-based red oxide (Type NB 20).
    - b. Aluminum: Mill finish (Type NB 50)
    - c. Hardware:
      - 1) Compression spring tubes: Anti-corrosive composite material.
      - 2) All other hardware: Zinc plated and chromate sealed.
      - 3) Corrosive environments: 316 stainless steel.

- 7. Insulation:
    - a. 1-inch rigid, high-density fiberboard insulation surrounding base.
    - b. 1-inch glass fiber insulation between exterior door cover and liner.
  - 8. Lifting Mechanism:
    - a. Compression spring operators enclosed in tubes, providing smooth and controlled cover operation throughout entire arc of opening and closing.
    - b. Upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside lower tube assembly.
    - c. Lower tube shall interlock with flanged support shoe.
      - 1) Steel construction: Through bolted to curb assembly.
      - 2) Aluminum construction: Welded to curb assembly.
  - 9. Hardware:
    - a. Hinges: Heavy-duty pintel hinge. Length denotes hinge side.
    - b. Spring latch with interior and exterior turn handles. Padlock hasp on inside only.
    - c. Provide latch strike as stamped component bolted to curb assembly.
    - d. Linkage:
      - 1) Heavy gage automatic hold open arm with red vinyl grip for opening and closing.
      - 2) Automatic lock in open position.
    - e. Bolt cover hardware into heavy gage channel reinforcing welded to underside of cover and concealed within insulation space.
- B. Accessories: Other materials not specifically described but required for complete, proper installation of roof specialties and accessories, subject to acceptance of Engineer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades:
  - 1. Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
  - 2. Mounting surfaces shall be straight and secure, substrates of proper width.
- B. Verification of Conditions: Verify that roof specialties and accessories may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies:
  - 1. Immediately notify Engineer in writing.
  - 2. Do not proceed with installation in areas of discrepancy until fully resolved.
  - 3. Commencement of installation signifies acceptance of surface conditions.

### **3.02 PREPARATION**

- A. Protection: Protect installed work and materials of other trades.

### **3.03 INSTALLATION**

- A. Install in accordance with manufacturer's recommendations and as shown on Drawings.
- B. Provide mechanical fasteners consistent with roof requirements.

### **3.04 REPAIR/RESTORATION**

- A. Touch up marred finishes, but replace units that cannot be restored to factory-finished appearance. Use materials, procedures recommended or furnished by manufacturer.

### **3.05 ADJUSTING**

- A. Adjust units to operate in proper manner and easily without binding.
- B. Replace damaged materials with new materials complying with specified requirements.

### **3.06 CLEANING**

- A. Site:
  - 1. Do not allow accumulation of scraps, debris arising from work of this section.
  - 2. Maintain premises in neat, orderly condition.
- B. System:
  - 1. Clean exposed surfaces of hatches and accessories using materials and methods recommended by manufacturer.
  - 2. When Work is completed, remove unused materials, containers, equipment, and debris.

### **3.07 DEMONSTRATION**

- A. Maintenance Instructions: Manufacturer's representative to schedule and attend meeting with Owner's representatives to explain:
  - 1. Maintenance and Care Instructions.
  - 2. Recommended Maintenance Program.
  - 3. Warranty Requirements.

### **3.08 PROTECTION**

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer to ensure work is without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

## SECTION 07 84 00

### PENETRATION FIRESTOPPING

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Penetrations in fire-resistance-rated walls.
- B. Related Sections:
  - 1. Section 07 84 46 "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

##### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
  - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.

##### 1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.



## 1.07 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

## PART 2 PRODUCTS

### 2.01 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. A/D Fire Protection Systems Inc.
  - 2. Grace Construction Products.
  - 3. Hilti, Inc.
  - 4. Johns Manville.
  - 5. Nelson Firestop Products.
  - 6. NUCO Inc.
  - 7. Passive Fire Protection Partners.
  - 8. RectorSeal Corporation.
  - 9. Specified Technologies Inc.
  - 10. 3M Fire Protection Products.
  - 11. Tremco, Inc.; Tremco Fire Protection Systems Group.
  - 12. USG Corporation.

### 2.02 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
  - 1. Fire-resistance-rated walls include fire-barrier walls.
  - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
  - 1. Retain first paragraph below if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.1. Coordinate with product selections in other Part 2 articles to ensure that products comply.
- D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
  - 1. Retain accessories in subparagraphs below required for penetration firestopping indicated.
  - 2. Permanent forming/damming/backing materials, including the following:
    - a. Slag-wool-fiber or rock-wool-fiber insulation.
    - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    - c. Fire-rated form board.
    - d. Fillers for sealants.
  - 3. Temporary forming materials.
  - 4. Substrate primers.
  - 5. Collars.

6. Steel sleeves.

## **2.03 FILL MATERIALS**

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- I. 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, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

## **2.04 MIXING**

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
  2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
  3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

### **3.03 INSTALLATION**

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- C. Install fill materials for firestopping by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### **3.04 IDENTIFICATION**

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  2. Contractor's name, address, and phone number.
  3. Designation of applicable testing and inspecting agency.
  4. Date of installation.
  5. Manufacturer's name.
  6. Installer's name.

### **3.05 CLEANING AND PROTECTION**

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or

deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

**END OF SECTION**

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## SECTION 07 84 46

### FIRE RESISTIVE JOINT SYSTEM

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Joints in or between fire-resistance-rated constructions.
- B. Related Sections:
  - 1. Section 07 84 13 "Penetration Firestopping" for penetrations in fire-resistance-rated walls.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

##### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

##### 1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

##### 1.07 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

## **PART 2 PRODUCTS**

### **2.01 FIRE-RESISTIVE JOINT SYSTEMS**

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
  
- B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:
  - 1. Joints include those installed in or between fire-resistance-rated walls.
  - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
  - 3. 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. A/D Fire Protection Systems Inc.
    - b. CEMCO.
    - c. Fire Trak Corp.
    - d. Grace Construction Products.
    - e. Hilti, Inc.
    - f. Johns Manville.
    - g. Nelson Firestop Products.
    - h. NUCO Inc.
    - i. Passive Fire Protection Partners.
    - j. RectorSeal Corporation.
    - k. Specified Technologies Inc.
    - l. 3M Fire Protection Products.
    - m. Tremco, Inc.; Tremco Fire Protection Systems Group.
    - n. USG Corporation.
  
- C. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
  
- D. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
  
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
  - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.

2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
  3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

### **3.03 INSTALLATION**

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
  2. Apply fill materials so they contact and adhere to substrates formed by joints.
  3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### **3.04 IDENTIFICATION**

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
  2. Contractor's name, address, and phone number.
  3. Designation of applicable testing agency.
  4. Date of installation.
  5. Manufacturer's name.
  6. Installer's name.

### **3.05 CLEANING AND PROTECTING**

- A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified.



**END OF SECTION**

## SECTION 07 92 00

### JOINT SEALANTS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide sealant and backup materials:
  - 1. Exterior construction joints.
  - 2. Interior joints.
- B. The following joint sealant is not included in this section:
  - 1. Interior and Exterior Concrete Slab Joint Sealant (Section 03 30 00).
  - 2. Sheet Metal Flashing and Trim (Section 07 62 00).
- C. Related Sections:
  - 1. Section 03 30 00 - Cast-in-Place Concrete
  - 2. Section 04 20 00 - Unit Masonry Assemblies
  - 3. Section 07 62 00 - Sheet Metal Flashing and Trim

##### 1.02 REFERENCES

- A. ASTM:
  - 1. C834 - Latex Sealants
  - 2. C919 - Use of Sealants in Acoustical Applications
  - 3. C920 - Elastomeric Joint Sealants
  - 4. C1021 - Laboratories Engaged in Testing Sealants
  - 5. C1193 - Standard Guide for Use of Sealants
  - 6. C1521 - Evaluation of Adhesion of Installed Weatherproofing Sealant Joints
  - 7. E119 - Fire Tests of Building Construction and Materials
  - 8. E548 - Evaluation and Assessment of Analytical Chemical Laboratories
- B. Sealant, Waterproofing, and Restoration Institute (SWRI)

##### 1.03 SYSTEM DESCRIPTION

- A. Performance Requirements: Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Environmental Requirements:
  - 1. Avoid indoor use of sealants that may contribute to indoor air quality problems, including the following:
    - a. Butyl rubber.
    - b. Solvent-based acrylic.
    - c. Neoprene.
    - d. Styrene butadiene rubber.
    - e. Nitrile.
    - f. Methylene chloride or chlorinated hydrocarbons.
    - g. Products containing bactericides and fungicides classified as phenol mercury acetates, phenol phenates, or phenol formaldehyde.
    - h. Provide acrylic latex or silicone sealants with less than 50 g/l VOCs.
    - i. Provide polyurethane products with less than 200 g/l VOCs.

##### 1.04 SUBMITTALS

- A. Refer to Section 01 33 00.

- B. Product Data:
  1. Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.
  2. Provide Product Data on manufacturer's adhesion and stain testing.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Color Samples: Submit manufacturer's standard color samples with Product Data and Shop Drawings.
- E. Environmental Submittals:
  1. Submit manufacturer's product data for adhesives and sealants, including printed statement of VOC content.
- F. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.
- G. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
  1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- H. Field Test Report Log: For each elastomeric sealant application.

## 1.05 QUALITY ASSURANCE

- A. Provide joint sealants units made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
- B. Qualifications:
  1. Manufacturer: 5 years experience in the manufacture of joint sealants.
  2. Contractor: 3 years experience in the installation of joint sealants.
  3. Personnel: For actual installation of joint sealants, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.
- C. Regulatory Requirements:
  1. Silicone Sealants: Certified by Sealant, Waterproofing, and Restoration Institute (SWRI).
- D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
  1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
  2. Conduct field tests for each application indicated below:
    - a. Each type of elastomeric sealant and joint substrate indicated.
    - b. Each type of non-elastomeric sealant and joint substrate indicated.
  3. Notify Architect 7 days in advance of dates and times when test joints will be erected.
  4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
  5. Method below is the first of 4 test methods recommended in Appendix X1.1 in ASTM C1193. Revise if one of the other three test methods is more appropriate for Project joint conditions.
    - a. Test method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193.
    - b. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  6. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.
- E. Preinstallation Meetings: The caulk installers, manufacturer's technical representative and Architect shall meet prior to the start of installation if requested.

## 1.06 PROJECT CONDITIONS

- A. Environmental Requirements:
1. Below 40 degrees F ambient temperature, refer to manufacturer's recommendations.
  2. Ensure joint substrates are dry and frost-free.
  3. Remove contaminants from joint substrate capable of interfering with adhesion.

## 1.07 WARRANTY

- A. Provide manufacturer's 5-year standard material warranty.
- B. Include coverage for replacement of sealant materials which fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. Joint Sealants:
1. Standard of Quality: Design is based on products of Tremco, Beachwood, OH [www.tremcosealants.com](http://www.tremcosealants.com), unless noted otherwise.
  2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Sonneborn by BASF, [www.basfbuildingsystems.com](http://www.basfbuildingsystems.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
      - 1) VOC content may be cause for rejection of comparable products submitted.
- B. Backer Rod/Backup Filler Materials:
1. Acceptable Manufacturers; subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Exterior Joints: Non-absorbent; *Sof-Rod* by Nomaco [www.nomaco.com](http://www.nomaco.com)
    - b. Interior Joints: Open-cell, *Den-verfoam* by Backer Rod Manufacturing and Supply [www.bayindustries.com/backerrod](http://www.bayindustries.com/backerrod)
    - c. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

### 2.02 MATERIALS

- A. Do not use materials stored longer than their maximum recommended shelf life.
- B. Exterior Construction Joint Sealant:
1. Silyl-terminated Polyether Sealant (MS polymer):
    - a. Low-modulus, high-movement, nonsag, fast-curing.
    - b. ASTM C920.
    - c. Type and grade: S (single component) and NS (nonsag).
    - d. Class: 100/50 for vertical joints.
    - e. Product:
      - 1) *Sonolastic 150 with VLM Technology* by BASF.
- C. Exterior Concealed Joints Under Thresholds: 1-part butyl rubber caulk conforming to FS TT-S-001657, Type 1.

- D. Aluminum, Sheet Metal, Glass, Glazing and Storefront Joint Sealants:
  - 1. Silyl-terminated Polyether Sealant:
    - a. Low-modulus, high-movement, nonsag, fast-curing.
    - b. ASTM C920.
    - c. Type and grade: S (single component) and NS (nonsag).
    - d. Class: 100/50 for vertical joints.
    - e. Product:
      - 1) *Sonolastic 150 with VLM Technology* by BASF.
- E. Interior Joint Sealants:
  - 1. Interior Dry Areas: Fast setting acrylic latex sealant meeting ASTM C834, Type P, Grade NF.
    - a. Product: *Tremflex 834*, by Tremco.
    - b. Maximum VOC content: 42 grams per liter.
  - 2. Interior Wet Areas: 1-part mildew-resistant silicone rubber conforming to ASTM C920, Type S, Grade NS.
    - a. Product: *Tremsil 200* by Tremco.
- F. Backup Filler Materials: Non-oily, non-staining, non-gassing, back-up filler or other filler completely compatible with sealant, approved by sealant manufacturer.
- G. Other Materials: Other materials not specifically described but required for complete, proper installation of joint sealants, subject to acceptance of Architect.
- H. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction and field tests.
- I. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

## 2.03 EQUIPMENT

- A. Must be specifically recommended for use by manufacturer of sealant being installed.

## 2.04 FINISHES

- A. Exterior: Selected by Architect from manufacturer's standard colors.
- B. Interior: Match paint color or adjoining substrate color.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- B. Verification of Conditions: Verify that joint sealants may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies: Immediately notify Architect. Do not proceed with installation in areas of discrepancy until fully resolved. Commencement of installation signifies acceptance of surface conditions.

### **3.02 PREPARATION**

- A. Surfaces to be Caulked: Verify that surfaces are sound, thoroughly dry, clean, free of oil, grease, laitance, rust, and other foreign material that would prevent proper adhesion, and that concrete and mortar are thoroughly cured.
- B. Masonry Cleaning: Complete before surface preparation is begun.
  - 1. Prepare joints and surfaces to receive sealants according to sealant manufacturer instructions.
  - 2. Rake and clean out joints to full depth and width.
  - 3. Clean concrete, masonry, other porous materials by brushing, grinding, other mechanical means, to provide sound, clean surface.
  - 4. Remove dust, dirt, loose particles resulting from mechanical cleaning by vacuuming or blowing out joints with compressed air.
- C. Clean glass, metal, and non-porous surfaces.
- D. Remove protective coatings on metal using solvent that leaves no residue.
  - 1. Use clean white cloths or lintless paper towels to apply solvent, and wipe surfaces dry with dry cloths or paper towels.
  - 2. Do not allow solvent to air dry without wiping.
- E. Mask joints as necessary to protect adjacent surfaces.
  - 1. Apply masking tape in continuous strips and carefully align with edge of joint.
  - 2. Remove masking immediately after joints have been sealed and tooled.

### **3.03 BACK-UP MATERIALS**

- A. Verify compatibility of filler material with sealant before installation.
- B. Install appropriate size backer rod directly into the control joint, larger than joint per manufacturer's recommendations, and in manner to provide concave sealant profile.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Where joint depth does not permit installation of backer rod, install adhesive-backed polyethylene bond-breaker tape along entire back of joint to prevent 3-sided adhesion of joint sealant.
- E. Use filler about 1/3 to 1/2 wider than width of joint so filler exerts sufficient pressure to provide substantial resistance to displacement.

### **3.04 SEALANT PRIMER**

- A. Prime all joints. Do not allow primer to get outside of joints.
- B. Apply as recommended by manufacturer of sealant.
- C. Prime and seal on same workday.

### **3.05 APPLICATION OF SEALANT**

- A. Apply strictly according to manufacturer's instructions, using nozzle of sufficient size to fill joint completely.

- B. Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  1. Place sealants so they directly contact and fully wet joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
  4. Install joint sealant to all joints except those that allow moisture to drain.
  5. Caulk wide joints with three passes.
  6. Run a bead at each inside corner, fill joint with third pass.
- E. Tool joints immediately after application of material to ensure full contact with adjacent surfaces.
- F. Strike off excess material. Finished bead is to be flush with adjoining surfaces, unless otherwise indicated on Drawings.

### **3.06 INSTALLATION OF PREFORMED FOAM SEALANTS**

- A. Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints.
- B. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.

### **3.07 CURING**

- A. Allow minimum 7 days for full cure.
- B. Do adhesion testing after 7 days.
- C. Painting Sealant:
  1. Allow 7 days to cure before applying paint.
  2. Match sealant to paint colors.

### **3.08 FIELD QUALITY CONTROL**

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
  1. Extent of Testing: Test completed elastomeric sealant joints as follows:
    - a. Perform 10 tests for the first 1,000 feet of joint length for each type of elastomeric sealant and joint substrate.
    - b. Perform 1 test for each 1,000 feet of joint length thereafter or 1 test per each floor per elevation.
  2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab or Method B, Exposed Surface Finish Hand Pull Tab or Method C, Field-Applied Sealant Joint Hand Pull Flap or Method D, Water Immersion in Appendix X1 in ASTM C1193, as appropriate for type of joint-sealant application indicated.
    - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; do this by extending cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.
  4. Inspect tested joints and report on the following:
    - a. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint

substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

- b. Whether sealants filled joint cavities and are free of voids.
  - c. Whether sealant dimensions and configurations comply with specified requirements.
5. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
  6. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

### **3.09 ADJUSTING**

- A. Non-compliant Work: Allow inspections of Work and assist in testing requested by manufacturer's representative and Architect. Remove adjacent Work until location is reached where installation was performed properly.
- B. Remove and replace uncured sealant.

### **3.10 CLEAN UP**

- A. Remove masking, excess material, smears as work progresses.
- B. Leave adjacent surfaces clean and free of sealant and primer.

### **3.11 PROTECTION**

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion.
- B. If damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

**END OF SECTION**



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## SECTION 08 11 13

### HOLLOW METAL DOORS AND FRAMES (COMMERCIAL)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Steel swing doors:
  - 2. Steel frames:
  - 3. Steel door and frame accessories including, but not limited to:
    - a. Glazing beads.
    - b. Door silencers.
- B. Furnish the following for other sections to install including, but not limited to:
  - 1. Masonry anchors.
- C. Perform the following:
  - 1. Prepare the door for hardware.
- D. Related Sections:
  - 1. Section 06 10 53 - Miscellaneous Rough Carpentry
  - 2. Section 08 16 00 - Corrosion Resistant Doors and Frames
  - 3. Section 08 71 00 - Door Hardware
  - 4. Section 09 92 70 - Coating Systems for Industrial Facilities

##### 1.02 REFERENCES

- A. ASTM:
  - 1. A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware
  - 2. A653 - Steel Sheet Galvanized or Galvannealed by the Hot Dip Process
  - 3. A1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy
  - 4. A1011 - Steel, Sheet and Strip, Hot Rolled Carbon, Structural, High-Strength
  - 5. E136 - Combustion Properties of Materials
- B. Door and Hardware Institute (DHI): Recommended Locations for Builder's Hardware
- C. NFPA 80 - Standard for Fire Doors and Windows
- D. SDI:
  - 1. 100 - Standard Steel Doors and Frames
  - 2. 105 - Erection Instructions for Steel Frames

##### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.
- C. Schedule of steel doors and frames using same reference numbers for details and openings as those on Drawings.
- D. Shop Drawings:
  - 1. Elevations of each door design.
  - 2. Details of doors, including vertical and horizontal edge details.

3. Frame details for each frame type, including dimensioned profiles.
  4. Details of locations of reinforcement and preparations for hardware.
  5. Details of each different wall opening condition.
  6. Details of anchorages, accessories, joints, and connections.
  7. Details of glazing frames and stops showing glazing.
  8. Details of conduit and preparations for electrified door hardware and controls.
- E. Coordination Drawings: Drawings of each opening, including door and frame, drawn to scale and coordinating door hardware. Show elevations of each door design type, showing dimensions, locations of door hardware, and preparations for power, signal, and control systems.
- F. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of steel door and frame.

#### **1.04 QUALITY ASSURANCE**

- A. Single Source Responsibility: Provide steel door and frame units made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
- B. Qualifications:
1. Manufacturer: 5 years experience in the manufacture of steel door and frame.
  2. Contractor: 3 years experience in the installation of steel door and frame.
  3. Personnel: For actual installation of steel door and frame, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.
- C. Regulatory Requirements:
1. Steel Door Institute: Comply with standards of ANSI/SDI-100.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store and handle doors and frames in accordance with manufacturer's recommendations.

#### **1.06 PROJECT CONDITIONS**

- A. Drawings do not purport to show actual dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

#### **1.07 COORDINATION**

- A. Coordinate installation of anchorages for steel frames.
- B. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry. Deliver to Site in time for installation.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURER**

- A. Hollow Metal Doors:
1. Standard of Quality: Design is based on products of Steelcraft, Cincinnati, OH [www.steelcraft.com](http://www.steelcraft.com)
  2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Amweld Building Products, Garrettsville, OH [www.amweld.com](http://www.amweld.com)
    - b. Ceco Door, Milan, TN [www.cecodoor.com](http://www.cecodoor.com)
    - c. Curries, Mason City, IA [www.curries.com](http://www.curries.com)

- d. Kewanee Corporation, Chicago, IL [www.kewaneecorp.com](http://www.kewaneecorp.com)
- e. Member of SDI; manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Hot-rolled Steel Sheets: Commercial steel (CS), pickled and oiled; comply with ASTM A1011, Type B. Free of scale, pitting, or surface defects.
- B. Cold-rolled Steel Sheets: Commercial steel (CS); comply with ASTM A1008, Type B.
- C. Galvanized Steel Sheets: Zinc-coated carbon, commercial steel (CS) type B; ASTM A653, with minimum A40 zinc-iron-alloy (galvannealed) coating designation.
- D. Supports, Anchors: Fabricate of not less than 18-gage galvanized sheet steel. Galvanize units to be built into exterior walls according to ASTM A153, Class B.
- E. Inserts, Bolts, Fasteners: Manufacturer's standard units, except hot-dip galvanized items to be built into exterior walls, comply with ASTM A153.
- F. Shop Applied Primer Paint: Rust-inhibitive enamel or paint, air-drying or baking, suitable as base for specified finish paints.
- G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur compounds, and other deleterious impurities.

## 2.03 FABRICATION

- A. Steel Door and Frame Units: Rigid, neat in appearance, free from defects, warp or buckle. Where practicable, fit and assemble in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment to assure proper assembly at the Site.
- B. Cold-rolled Steel: Exposed faces of doors and panels, including stiles, rails of nonflush units.
- C. Cold-rolled or hot-rolled steel at fabricator's option: Frames, concealed stiffeners, reinforcement, edge channels, louvers, moldings.
- D. Exposed Fasteners: Countersunk flat phillips heads unless otherwise indicated.
- E. Finish Hardware Preparation:
  - 1. Factory prepare steel doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 08 71 00.
  - 2. Reinforce doors and frames to receive nontemplated mortised and surface-mounted door hardware.
  - 3. Comply with Door Hardware Institute specifications and ANSI A250 for door and frame preparation and location for hardware
- F. Galvanizing: Exterior doors and frames
- G. Weep Holes: Provide in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
- H. Shop Painting:
  - 1. Clean, treat, paint exposed surfaces of units, including galvanized surfaces.
  - 2. Clean steel surfaces of mill scale, rust, oil, grease, dirt, other foreign materials.
  - 3. Correct minor irregularities with metallic putty sanded smooth before application of paint.

4. Apply shop coat prime paint of even consistency to provide uniformly finished surface ready to receive finish paint.

## 2.04 STANDARD STEEL DOORS

1. Exterior Doors:
    - a. Face sheets fabricated from metallic-coated steel sheet.
    - b. Level: SDI Grade III (extra heavy duty).
    - c. Model: Model 2 (16 gage): Fully welded seamless, including top of door.
    - d. Core: Polystyrene core.
  2. Interior Doors:
    - a. Face sheets fabricated from cold-rolled steel **or** metallic-coated sheet.
    - b. Level: SDI Grade II (heavy duty).
    - c. Model:
      - 1) Model 2 (18 gage): Face: Fully welded seamless, including top of door.
    - d. Core: Kraft honeycomb.
- B. End Closures:
1. Close off top and bottom of doors with 18-gage (minimum) end closure channels, flush top, inverted bottom.
  2. Provide sealant at top of exterior doors for water-tight condition.
- C. Edges: Bevel edges on both sides.
- D. Swing Door Hardware - SDI recommended hardware reinforcing gages:
1. Hinge Reinforcements: 10-gage: 1-1/2 inches by 9 inches.
  2. Lock Front and Flush Bolt Reinforcement: 14-gage, 1/2 inch by 3 inches.
  3. Cylindrical Lock Reinforcement Units: 14 gage.
  4. Mortised Hardware: 14 gage, preparation in accordance with ANSI A250 where applicable. Reinforce, drill and tap to receive hardware.
  5. Closer Reinforcement: 14 gage channel, 14 inches long, or to suit closer length, install on all doors.
  6. Other Hardware: Refer to SDI recommendations (minimum).
  7. Through Bolting: Not allowed.
- E. Accessories:
1. Glazing Beads: Removable glazing bead on interior side of glass only; exterior glazing stop shall be non-removable.
- F. Label Requirements: Meet all requirements, as set forth by Underwriters Laboratories, Inc., for all label classifications. UL Laboratories, Inc. or Warnock Hersey requirements shall take precedence in all cases.

## 2.05 STANDARD STEEL FRAMES

- A. General Requirements:
1. Verify quantities and suitability of fasteners.
  2. Conceal fastenings, unless otherwise indicated.
  3. Exterior Frames: Metallic-coated steel sheet with mitered corners.
  4. Interior Frames: Cold-rolled steel (uncoated) or Metallic-coated sheet with mitered corners.
  5. Continuous welded and backwelded corners (through stops).
  6. Thickness: 0.053-inch-thick steel sheet.
  7. Reinforce for hardware using the SDI Hardware Reinforcing Gages as a minimum standard.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing work, carefully inspect, with Installer present, and verify that work is complete to point where this installation may properly commence.
- B. Verification of Conditions: Verify that steel doors and frames may be installed in accordance with original design, installation tolerances, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies:
  - 1. Immediately notify Engineer.
  - 2. Do not proceed with installation in areas of discrepancy until fully resolved.
  - 3. Commencement of installation signifies acceptance of surface conditions

### **3.02 PREPARATION**

- A. Remove welded-in shipping spreaders installed at factory.
- B. Prior to installation and with installation spreaders in place, adjust and securely brace steel door frames for squareness, alignment, twist, and plumb to the following tolerances:
  - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
  - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
  - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
  - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

### **3.03 INSTALLATION**

- A. Install steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Frames:
  - 1. Comply with SDI-105:
  - 2. Except for frames located at in-place concrete or masonry and at drywall installations, place prior to construction at enclosing walls and ceilings.
  - 3. Set accurately in position, plumbed, aligned, braced securely until permanent anchors set.
  - 4. Remove temporary braces and spreaders after wall construction is completed, leaving surfaces smooth and undamaged.
- C. Anchors:
  - 1. Floor anchors: Provide for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors. Powder-actuated fasteners may be used if indicated and approved on Shop Drawings.
  - 2. Masonry construction: Locate 3 wall anchors per jamb at hinge and strike levels.
  - 3. In-place concrete or masonry construction: Set, secure to adjacent construction with machine screws and masonry anchorage devices.
  - 4. In-place gypsum board partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors and fill and make smooth, flush, and invisible on exposed faces.
  - 5. Metal stud partitions: Install minimum 3 wall anchors per jamb at hinge and strike levels.
  - 6. Open steel stud partitions: Place studs in wall anchor notches, wire tie.
  - 7. Closed steel stud partitions: Attach wall anchors to studs with tapping screws.

8. Where frames require existing opening anchors, "dimple" to receive countersunk flathead expansion anchor screws, setting screw heads below surface of frame. Fill countersink with metal putty, grind smooth to match adjacent surface. Prime affected area to match shop finish.

D. Door Installation:

1. Fit accurately in frames within clearances specified in SDI-100.
2. Shim as necessary.

### **3.04 ADJUSTING, CLEANING**

- A. Remove and replace defective work, including steel doors or frames that are warped, bowed, or otherwise unacceptable.
- B. Clean grout and other bonding material off doors and frames immediately after installation.
- C. Prime Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat; apply touch-up of compatible air-drying primer.
- D. Galvanized Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- E. Final Adjustments: Check, readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

### **3.05 SCHEDULE**

- A. Furnish items in amounts indicated on Drawings or required for complete and operable facility.
- B. Coordinate Schedule with Drawings and notify Engineer of any door not scheduled.

**END OF SECTION**

## SECTION 08 45 13

### TRANSLUCENT WINDOW SYSTEM

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes requirements for translucent window system as shown and specified herein.

##### 1.02 WORK INCLUDED

- A. Design, engineer, manufacture, and installation of translucent window system.
- B. All anchors, brackets, and hardware attachments necessary to complete the specified structural assembly, weatherability, and water-tightness performance requirements. All flashing up to but not penetrating adjoining work are also required as part of the system and shall be included.
- C. Trained and factory authorized labor and supervision to complete the entire panel installation.

##### 1.03 RELATED WORK ELSEWHERE

- A. Sheet Metal and Flashing
- B. Sealant

##### 1.04 QUALITY ASSURANCE

- A. The glazing panels must be evaluated and listed by recognized building code evaluation organization: International Council Evaluation Service Inc (ICC-ES).
- B. Materials and products shall be manufactured by a company continuously and regularly employed in the manufacturing, engineering, and designing, stocking and building of unitized translucent window/walls for a period of at least ten (10) years.
- C. Erection shall be by an installer who has been in the business of erecting similar material for at least five (5) consecutive years and can show evidence of satisfactory completion of projects of similar size, scope, and type.
- D. The manufacturer shall be responsible for the configuration and fabrication of the complete panel system, in accordance with the requirements of this specification.

##### 1.05 SUBMITTALS

- A. Submit Shop drawings and color samples.
- B. Manufacturer shall submit written guarantee accompanied by substantiating data, stating that the products to be furnished are in accordance with or exceed these specifications.
- C. Manufacturer shall submit full warranty and sales terms and conditions for verification of compliance with the requirements of this specification.
- D. Submittal: For glazing assemblies to comply with performance requirements and design criteria,

##### 1.06 MAINTENANCE DATA

- A. The manufacturer shall provide recommended maintenance procedures, schedule of maintenance and materials required or recommended for maintenance.



- B. Submit installer certificate signed by installer, certifying compliance with project qualification requirements.

## **1.07 WARRANTY**

- A. Provide a single source translucent window systems manufacturer warranty against defective materials and fabrication. Submit manufacturer's written warranty agreeing to repair failures in materials within one (1) year from date of delivery.
- B. Provide the following single source translucent window manufacturer glazing warranties. Third party warranties shall not be acceptable. All warranties shall be maintained without any system maintenance requirements of the owner's responsibility. The expected humidity of the enclosed space shall not affect warranty length.
  - 1. Provide a lifetime warranty for both interior and exterior glazing covering:
    - a. Delamination of the glazing from the internal structure.
    - b. Fiberbloom; development of a rough exterior surface.
  - 2. Provide a ten (10) warranty on the interior glazing covering:
    - a. Change in light transmission of no more than 6% per ASTM D-1003.
    - b. Color stability: interior glazing shall not change color more than 6 CIE Units DELTA E by ASTM D-2244.
  - 3. Provide a ten (10) year warranty on the exterior glazing covering:
    - a. Change in light transmission of no more than 6% per ASTM D-1003.
    - b. Color stability: exterior glazing shall not change color more than 6 CIE Units DELTA E by ASTM D-2244.
  - 4. Blue light spectrum (400-470nm) measured in accordance with ASTM E-1175 shall not decrease by no more than 6% after ten years in comparison with the original value.
    - a.
- C. In addition, submit installer's written warranty agreeing to repair installation workmanship, defects and leaks within one year from date of delivery.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Basis of design
  - 1. The design and performance criteria of this job are based on the UniQuad Translucent Window–pre-fabricated, pre-assembled glazing, system as manufactured by Kingspan Light + Air | Architectural Daylighting
  - 2. Phone: (800) 759-6965 Website: [www.kingspanlightandair.us](http://www.kingspanlightandair.us)
- B. Approved Manufacturers
  - 1. Other manufacturers may bid this project provided they comply with all requirements of the specification and submit evidence of compliance with all performance criteria specified herein. This evidence must include proof of conformance and test reports per section 1.5. Any exceptions taken from this specification must be noted on the approval request. If no exceptions are noted and approval is given, product performance will be as specified.
  - 2. Listing manufacturers names in this specification does not constitute approval of their products or relieve them of compliance with all the performance and design requirements contained herein.

### **2.02 TRANSLUCENT WINDOW PERFORMANCE AND APPEARANCE**

- A. Glazing construction for longevity and resistance to buckling and pressure
  - 1. Translucent glazing must be constructed of tight cell sizes not exceeding 0.18". Wide cells of size greater than 0.18" shall not be acceptable.
- B. Translucent glazing assemblies – Unitized Double Glazed

1. Design, engineer, manufacture, and installation of unitized double-glazed translucent window system. An assembly of two independent insulated glazing panes in one integrated assembly, incorporated into a complete aluminum frame system that has been tested and warranted by the manufacturer as a single source system. Design shall provide for the replacement of the exterior glazing, independently of the interior glazing without exposing the building's interior or compromising the weather tightness of interfering with the normal working functions of the building. Single pane glazing systems are not acceptable.
  2. Overall glazing assembly thickness shall be a minimum 2.75", with two glazing panes and concealed interlocking connector. Thickness of the exterior and interior glazing shall be minimum 8mm thick each.
- C. Thermal and Solar Performance
1. To ensure Energy Code compliance, product U-Values must be listed in the NFRC Product Directory and have a Certified Product Directory (CPD) number.
    - a. Basis of Design CPD Number: UQTW
  2. Center of glazing U-Value per NFRC 100: Maximum .25.
  3. System U-Value per NFRC 100 and 700: Maximum .30.
  4. Haze measurement minimum of 90% per ASTM D-1003.
  5. Standard exterior glazing color: Clear Matte
  6. Standard interior glazing color: Clear Matte
- D. Translucent Glazing Joint System
1. Water penetration: no water penetration of the glazing joint connection length at test pressure of 6.24 PSF per ASTM E-331.
  2. Air Infiltration: pass requirements of NFRC 400 at 1.57 PSF and 6.24 PSF.
  3. Air Exfiltration: pass requirements of NFRC 400 at 1.57 PSF and 6.24 PSF.
  4. Free movement of the glazing shall be allowed to occur without damage to the weather tightness of the completed system.
  5. The glazing joint shall comply with the deflection limitation of IBC Table 1604.3 for exterior walls with flexible finishes – L/120 per IBC.
- E. Flammability
1. Exterior Glazing
    - a. Class A interior flame spread per ASTM E-84
    - b. Flame spread no greater than zero (0) and smoke density no greater than 110 per ASTM E-84.
    - c. Minimum self-ignition temperature of 1120° per ASTM 1929.
  2. Interior Glazing
    - a. Class A interior flame spread per ASTM E-84
    - b. Flame spread no greater than zero (0) and smoke density no greater than 110 per ASTM E-84.
    - c. Minimum self-ignition temperature of 1120° per ASTM 1929.
- F. Impact Resistance
1. Minimum Impact loading of 500 ft. lbs. per ASTM E-695.
- G. Weatherability
1. The light transmission shall not decrease more than 6% as measured by ASTM D-1003 over 10 years, or after exposure to temperature of 300° for 25 minutes (thermal aging performance standard).
  2. The weathering performance should be justified by successful testing of the glazing's performance after exposure to actual Florida weather conditions for approximately 10 years in comparison to a new glazing assembly. This performance must be demonstrated by providing independent lab test reports for the exposed and a new panel assembly for the following tests; test results must show that there is no deterioration in performance for the 10 year's exposed panels versus new:
    - a. Uniform static air pressure per ASTM E-330 at negative load of -105 PSF and positive load of 130 PSF.

- b. Impact loading of 500 ft.lbs. per ASTM E-695.
- c. Cyclic static air pressure at 65 PSF and impact lever D per ASTM 1886 and ASTM E-1996.
- 3. Glazing must be manufactured with a permanent, co-extruded ultra-violet protective layer. Post-applied coatings or films of dissimilar materials that need to be maintained are unacceptable.
- 4. Glazing shall not become readily detached when exposed to temperatures of 300°F and 0°F for 25 minutes.
- 5. Thermal aging – the interior and exterior glazing shall not change color in excess of 0.75 Delta E per ASTM D-2244 and shall not darken more than 0.3 units Delta L per ASTM D-2244 and shall allow no cracking or crazing when exposed to 300°F for 25 minutes.
- 6. Glazing shall be factory sealed to restrict dirt ingress.

## **2.03 METAL FRAME STRUCTURE**

- A. The wall light framing is designed to be self-supporting between the support constructions. The deflection of the system framing members in a direction normal to the plane of the glazing, when subjected to a uniform load deflection, shall not exceed L/120 for the unsupported span per IBC Table 1604.3. All adjacent and support construction must support the transfer of all loads included horizontal and vertical, exerted by the system. Design or structural engineering services for the supporting structure or building components in not included in the translucent window scope of this section
- B. All window system aluminum framing exposed to the exterior shall be thermally broken.
- C. Water penetration: the translucent window system shall allow no water penetration at a minimum differential static pressure of 6.24 PSF per AAMA 501 pressure difference recommendations and as demonstrated by prior testing of typical framing sample per ASTM E-331
- D. Water test of meal frame structure shall be conducted according to procedures in AAMA 501.2.

## **2.04 METAL MATERIALS**

- A. Extruded aluminum shall be ANSI/ASTM B-221; 6063-T6 or 6005-T5.
- B. Flashing:
  - 1. 5005 H34 Aluminum .040" thick
  - 2. Sheet metal sill flashings are to be furnished shop formed to profile - when lengths exceed 10ft, provide in nominal 10ft lengths. Field trimming of the flashing and field forming the ends is necessary to suit as-built conditions. Sheet metal ends are to overlap at least 6in to 8in, set in a full bed of sealant and riveted if required.
- C. All fasteners for aluminum framing to be stainless steel or cadmium plated steel, excluding the final fasteners to the building.
- D. All exposed ALUMINUM FINISH shall be from manufacturer standard color range:
  - 1. Options as follows:
    - a. PREMIUM polymer resin powder coat per AAMA 2604 with 10 years warranty

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. General contractor to verify when structural support is ready to receive all work in the section and to convene a pre-installation conference at least one week prior to commencing work of this section. Attendance required of the general contractor, translucent window installer and all parties affecting and effected by the work of this section.
- B. All submitted opening sizes, dimensions and tolerances are to be field verified by the general contractor unless otherwise stipulated.

- C. Installer shall examine area of installation to verify readiness of site conditions. Notify the general contractor about any defects requiring correction. Do not work until conditions are satisfactory.

### **3.02 INSTALLATION**

- A. Install components in strict accordance with manufacturer's instructions and approved shop drawings. Use proper fasteners, caulking and hardware for material attachments as specified.
- B. Use methods of attachment to structure allowing sufficient adjustment to accommodate tolerances.
- C. Remove all protective coverings on panels immediately after installation.

### **3.03 CLEANING**

- A. Follow manufacturer's instructions when washing down exposed panel surfaces using a solution of mild detergent in warm water that is applied with soft, cleaning wiping cloths. Always test a small area before applying to an entire area.
- B. Follow strict panel manufacturer guidelines when removing foreign substances from panel surfaces requiring mineral spirits or any solvents that are acceptable for use. Always test a small sample to validate compliance before applying to the entire glazing surface.
- C. Installer shall leave glazing system clean at completion of installation. Final cleaning is by others upon completion of project, following manufacturer's cleaning instructions.

**END OF SECTION**

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## SECTION 08 71 00

### DOOR HARDWARE

#### PART 1 GENERAL

##### 1.01 CONDITIONS

- A. Conditions of the contract (General and Supplementary Conditions) and Division One General Requirements, govern the work of this section.
- B. This section includes all material, and related service necessary to furnish all finish hardware indicated on the drawings, or specified herein.
- C. Furnish UL listed hardware for all labeled and 20 min. openings in conformance with the requirements for the class of opening scheduled. Underwriters' requirements shall have precedence over specification where conflicts exist.
- D. All work shall be in accordance with all applicable state and local building codes. Code requirements shall have precedence over this specification where conflicts exist.

##### 1.02 WORK INCLUDED

- A. This section includes the following:
  - 1. Furnish door hardware specified herein, listed in the hardware schedule, and/or required by the drawings.
- B. Where items of hardware are not definitely or correctly specified and is required for the intended service, such omission, error or other discrepancy should be directed to the Architect prior to the bid date for clarification by addendum. Otherwise furnish such items in the type and quantity established by this specification for the appropriate service intended.

##### 1.03 RELATED WORK IN OTHER SECTIONS

- A. This section includes coordination with related work in the following sections:
  - 1. Division 6 Section "Finish Carpentry".
  - 2. Division 8 Section "Doors and Frames".
  - 3. Division 28 Sections "Electrical".

##### 1.04 REFERENCES

- A. Publications of agencies and organizations listed below form a part of this specification section to the extent referenced.
  - 1. DHI - Recommended Locations for Builders' Hardware.
  - 2. NFPA 80 - Standards for Fire Doors and Windows.
  - 3. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
  - 4. UL - Building Material Directory.
  - 5. DHI - Door and Hardware Institute.
  - 6. WHI - Warnock Hersey.
  - 7. BHMA - Builders Hardware Manufacturers Association.
  - 8. ANSI - American National Standards Institute.
  - 9. IBC 2012 - International Building Code 2012 Edition (as amended by local building code).

##### 1.05 SUBMITTALS

- A. Within ten days after award of contract, submit detailed hardware schedule in quantities as required by Division 1 - General Conditions.

- B. Schedule format shall be consistent with recommendations for a vertical format as set forth in the Door & Hardware Institute's (DHI) publication "Sequence and Format for the Hardware Schedule". Hardware sets shall be consolidated to group multiple door openings which share similar hardware requirements. Schedule shall include the following information:
  - 1. Door number, location, size, handing, and rating.
  - 2. Door and frame material, handing.
  - 3. Degree of swing.
  - 4. Manufacturer.
  - 5. Product name and catalog number.
  - 6. Function, type and style.
  - 7. Size and finish of each item.
  - 8. Mounting heights.
  - 9. Explanation of abbreviations, symbols, etc.
  - 10. Numerical door index, indicating the hardware set/ group number for each door.
- C. When universal type door closers are to be provided, the schedule shall indicate the application method to be used for installation at each door: (regular arm, parallel arm, or top jamb).
- D. The schedule will be prepared under the direct supervision of a certified Architectural Hardware Consultant (AHC), or certified Door Hardware Consultant (DHC) employed by the hardware distributor. The hardware schedule shall be signed and embossed or stamped with the DHI certification seal of the supervising AHC or DHC. The supervising AHC or DHC shall attend any meetings related to the project when requested by the architect.
- E. Check the specified hardware for suitability and adaptability to the details and surrounding conditions.
- F. Review drawings from related trades as required to verify compatibility with specified hardware. Indicate unsuitable or incompatible items, and proposed substitutions in the hardware schedule.
- G. Provide documentation for all hardware to be furnished on labeled fire doors indicating compliance with positive pressure fire testing UL 10C.
- H. Furnish manufacturers' catalog data for each item of hardware in quantities as required by Division 1 - General Conditions.
- I. Furnish with first submittal, a list of required lead times for all hardware items.
- J. After final approved schedule is returned, transmit corrected copies for distribution and field use in quantities as required by Division 1 - General Conditions.
- K. Furnish approved hardware schedules, template lists, and pertinent templates as requested by related trades.
- L. Furnish necessary diagrams, schematics, voltage and amperage requirements for all electro-mechanical devices or systems as required by related trades. Wiring diagrams shall be opening specific and include both a riser diagram and point to point diagram showing all wiring terminations.
- M. After receipt of approved hardware schedule, Hardware supplier shall initiate a meeting including the owner's representative to determine keying requirements. Upon completion of the initial key meeting, hardware supplier shall prepare a proposed key schedule with symbols and abbreviations as set forth in the door and hardware institute's publication "Keying Procedures, Systems, and Nomenclature". Submit copies of owner approved key schedule for review and field use in quantities as required by Division 1 - General Conditions.

## **1.06 QUALITY ASSURANCE**

- A. Manufacturers and model numbers listed are to establish a standard of function and quality. Similar items by approved manufacturers that are equal in design, function, and quality, may be considered

for prior approval of the architect, provided the required data and physical samples are submitted for approval as set forth in Division One General Requirements.

- B. Where indicated in this specification, products shall be independently certified by ANSI for compliance with relevant ANSI/BHMA Standards A156.1 - A156.36 - Standards for Hardware and Specialties. All products shall meet or exceed certification requirements for the respective grade indicated within this specification. Supplier shall provide evidence of certification when requested by the architect.
- C. Obtain each type of hardware (hinges, latch & locksets, exit devices, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.
- D. Electrical drawings and electrical specifications are based on the specific electrified hardware components specified in hardware sets. When electronic hardware components other than those indicated in hardware sets are provided, the supplier shall be responsible for all costs incurred by the design team and their consultants to review, and revise electrical drawings and electrical specifications. Supplier shall also be responsible for any additional costs associated with required changes in related equipment, materials, installation, or final hook up to insure the system will operate and function as indicated in the construction documents, including hardware set operational/functional descriptions.
- E. All hardware items shall be manufactured no earlier than 6 months prior to delivery to site.
- F. Hardware supplier shall be factory trained and certified by the manufacture to provide and support all computer managed locks and system components.
- G. Installation of hardware shall be installed or directly supervised and inspected by a skilled installer certified by the manufacturer of locksets, door closers, and exit devices used on the project, or with not less than 3 years' experience in successful completion of projects similar in size and scope.
- H. Provide hardware for all labeled fire doors, which complies with positive pressure fire testing UL 10C.
- I. Comply with all applicable provisions of the standards referenced within Section 1.4 of this specification.
- J. Hardware supplier shall participate when reasonably requested to meet with the contractor and or architect to inspect any claim for incorrect or non-functioning materials; following such inspection, the hardware supplier shall provide a written statement documenting the cause and proposed remedy of any unresolved items.

#### **1.07 DELIVERY, STORAGE AND HANDLING**

- A. Hardware supplier shall deliver hardware to the job site unless otherwise specified.
- B. All hardware shall be delivered in manufacturers' original cartons and shall be clearly marked with set and door number.
- C. Coordinate with contractor prior to hardware delivery and recommend secure storage and protection against loss and damage at job site.
- D. Contractor shall receive all hardware and provide secure and proper protection of all hardware items to avoid delays caused by lost or damaged hardware. Contractor shall report shortages to the Architect and hardware supplier immediately after receipt of material at the job site.
- E. Coordinate with related trades under the direction of the contractor for delivery of hardware items necessary for factory installation.



## 1.08 WARRANTY

- A. All hardware items shall be warranted against defects in material and workmanship as set forth in Division One General Requirements.
- B. Repair, replace, or otherwise correct deficient materials and workmanship without additional cost to owner.

## PART 2 PRODUCTS

### 2.01 FASTENERS

- A. All exposed fasteners shall be Phillips head or as otherwise specified, and shall match the finish of the adjacent hardware. All fasteners exposed to the weather shall be non-ferrous or stainless steel. Furnish correct fasteners to accommodate surrounding conditions.
- B. Coordinate required reinforcements for doors and frames. Seek approval of the architect prior to furnishing through-bolts. Furnish through-bolts as required for materials not readily reinforced.

### 2.02 BUTT HINGES

- A. Acceptable manufacturers and respective catalog numbers:
  - 1. Heavy Weight, Ball Bearing, Non-Ferrous 

<u>Ives</u>	<u>Stanley</u>	<u>Hager</u>	<u>McKinney</u>
5BB1HW	FBB199	BB1199	T4B3386
- B. Hinges shall be independently certified by ANSI for compliance with ANSI A156.1 (2006). Hinges shall meet or exceed the following ANSI grade requirements as indicated below:
  - 1. Heavy Weight, 4 Ball Bearing Hinges: Grade 1
- C. Unless otherwise specified, furnish the following hinge quantities for each door leaf.
  - 1. 3 hinges for interior doors.
  - 2. 4 hinges Exterior Doors.
- D. Unless otherwise specified, top and bottom hinges shall be located as specified in Division 8 Section "Hollow Metal Doors and Frames". Intermediate hinges shall be located equidistant from others.
- E. Furnish hinges for ALL DOORS from stainless steel.
- F. Unless otherwise specified, furnish hinges in the following sizes:
  - 1. 5-inch by 5-inch, 2-1/4-inch thick doors.
  - 2. 4-1/2-inch by 4-1/2-inch, 1-3/4-inch thick doors.
  - 3. 3-1/2-inch by 3-1/2-inch, 1-3/8-inch thick doors.
- G. Furnish hinges with sufficient width to accommodate trim and allow for 180-degree swing.
- H. Unless otherwise specified, furnish hinges with flat button tips with non-rising pins at interior doors, non-removable loose pins (NRP) at exterior and out-swinging interior doors.
- I. Unless otherwise specified, furnish all hinges to template standards.

## 2.03 EXIT DEVICES

- A. Acceptable manufacturers and respective catalog numbers:
- |                                       | <u>Von Duprin</u> | <u>Detex</u>          |
|---------------------------------------|-------------------|-----------------------|
| Wide Stile, Push Pad                  | 99 Series         | Advantex (Wide Stile) |
| Wide Stile, Electric Latch Retraction | QEL 99 Series     |                       |
| Lever Trim                            | 996 Series        | "D/DM" Trim           |
| Pull Trim                             | 990 Series        | "C" Trim              |
- B. Exit devices shall be independently certified by ANSI for compliance with ANSI A156.3, Grade 1 (2008).
- C. Obtain exit devices from a single manufacturer, although several may be indicated as offering products complying with requirements.
- D. All exit devices shall be provided with dead-locking latch bolts to insure security.
- E. All exit devices shall be U.L. listed for accident hazard. Exit device for use on fire doors shall also be U.L. listed for fire exit hardware.
- F. Provide optional strikes, special length rods, and adapter plates to accommodate door and frame conditions. Provide narrow style series devices in lieu of wide stile series devices where optional strikes will not accommodate door and frame conditions.
- G. Coordinate with related trades to insure adequate clearance and reinforcement is provided in doors and frames. Provide thru bolts as required.
- H. Refer to hardware groups for exit device applications utilizing the option of: "less bottom rod and floor strike" (LBR)
- I. All exit devices shall be provided with optional trim designs to match other lever and pull designs used on the project.
- J. Unless specific exit device dogging options are noted within hardware sets, provide dogging options as follows:
- K. Fire Rated devices: Dogging not permitted.
- L. Non-Rated Exit Only functions not equipped with outside trim or pull: Less Dogging.
- M. Non-Rated Classroom functions: Less Dogging.
- N. Non-Rated devices utilizing electric latch retraction or electrified outside trim: Less Dogging.
- O. All Other Non-Rated devices: Cylinder Dogging utilizing interchangeable core cylinders. Cylinder keyway shall match locksets furnished on this project.
- P. Provide glass bead kits as required to accommodate door conditions. Screws shall not be visible through full glass doors.
- Q. Where specified, provide compatible keyed mullions with cylinder for pairs of doors.
- R. Provide reinforced crossbars for all traditional style exit devices applied to doors over 36 inches wide.

## 2.04 LOCKS AND LATCHES

- A. Acceptable manufacturers and respective catalog numbers:
- |                 |                |                |
|-----------------|----------------|----------------|
|                 | <u>Schlage</u> | <u>Sargent</u> |
| Grade 1 Mortise | L Series 17A   | 8200 LNL       |
- B. Unless otherwise specified, all locks and latches to have:
1. 2-3/4-inch Backset.
  2. 1/2-inch minimum throw latchbolt.
  3. 1-inch throw deadbolt.
  4. 6-pin cylinders.
  5. ANSI A115.2 strikes.
- C. Provide guarded latch bolts for all locksets, and latch bolts with sufficient throw to maintain fire rating of both single and paired door assemblies.
- D. Length of strike lip shall be sufficient to clear surrounding trim.
- E. Provide wrought boxes for strikes at inactive doors, wood frames, and metal frames without integral mortar covers.

## 2.05 PULLS, PUSH BARS, PUSH/PULL PLATES

- A. Acceptable manufacturers and respective catalog numbers:
- |                                  |              |              |               |
|----------------------------------|--------------|--------------|---------------|
|                                  | <u>Burns</u> | <u>Hager</u> | <u>Ives</u>   |
| Straight Pull (1" dia., 10" ctc) | 26C          | 4J           | 8103-0        |
| Push Plate (.050 6" x 16")       | 56           | 30S 6 x 16   | 8200 6" x 16" |
- B. Adjust dimensions of push plates to accommodate stile and rail dimensions, lite and louver cutouts, and adjacent hardware. Where required by adjacent hardware, push plates shall be factory drilled for cylinders or other mortised hardware. All push plates shall be beveled 4 sides and counter sunk.
- C. Where possible, provide back-to-back, and concealed mounting for pulls and push bars. Push bar length shall be 3 inches less door width, or center of stile to center of stile for stile and rail or full glass doors.

## 2.06 COORDINATORS

- A. Acceptable manufacturers and respective catalog numbers:
- |                  |             |                      |              |
|------------------|-------------|----------------------|--------------|
|                  | <u>Ives</u> | <u>Door Controls</u> | <u>Hager</u> |
| Bar Coordinator  | COR x FL    | 600 x Filler         | 297D x 297F  |
| Mounting Bracket | MB Series   | AB, C Series         | 297 Series   |
- B. Provide coordinators at all pairs of doors having automatic flush bolts and closers on the inactive leaf, and for pairs of doors having vertical rod/mortise exit device combinations with overlapping astragals.
- C. Provide appropriate filler bars, closer mounting brackets, carry bars, and special top latch preparations as required by adjacent hardware.

## 2.07 CLOSERS

- A. Acceptable manufacturers and respective catalog numbers:
- |                |              |               |             |
|----------------|--------------|---------------|-------------|
|                | <u>LCN</u>   | <u>Norton</u> | <u>Yale</u> |
| 4050 /4050 EDA | R7500/PR7500 | 4400          |             |
- B. Door closers shall be independently certified by ANSI for compliance with ANSI A156.4, Grade 1 (2013).

- C. Obtain door closers from a single manufacturer, although several may be indicated as offering products complying with requirements.
- D. Provide extra heavy duty arm (EDA/HD) when closer is to be installed using parallel arm mounting.
- E. Hardware supplier shall coordinate with related trades to insure aluminum frame profiles will accommodate specified door closers.
- F. Closers shall use aluminum cylinders.
- G. Closers for fire-rated doors shall be provided with temperature stabilizing fluid that complies with Standards UL10C.
- H. Unless otherwise specified, all door closers shall have full covers and separate adjusting valves for sweeps, latch, and backcheck.
- I. Provide closers for all labeled doors. Provide closer series and type consistent with other closers for similar doors specified elsewhere on the project.
- J. Provide closers with adjustable spring power. Size closers to insure exterior and fire rated doors will consistently close and latch doors under existing conditions. Size all other door closers to allow for reduced opening force not to exceed 5 pounds.
- K. Install closers on the room side of corridor doors, stair side of stairways and interior side of exterior doors.
- L. Closers shall be furnished complete with all mounting brackets and cover plates as required by door and frame conditions, and by adjacent hardware.

## 2.08 OVERHEAD STOPS

- A. Acceptable manufacturers and respective catalog numbers:
 

	<u>Glynn-Johnson</u>	<u>Rixson</u>	<u>Sargent</u>
Heavy Duty Surface Mount	GJ900 Series	9 Series	590
- B. Unless otherwise specified, furnish GJ900 series overhead stop for hollow metal or 1-3/4-inch solid core doors equipped with regular arm surface type closers that swing more than 140 degrees before striking a wall, for hollow metal or 1-3/4-inch solid core doors that open against equipment, casework, sidelights, or other objects that would make wall bumpers inappropriate, and as specified in hardware groups.
- C. Furnish sex bolt attachments for wood and mineral core doors unless doors are supplied with proper reinforcing blocks.
- D. Do not provide holder function for labeled doors.

## 2.09 WALL STOPS AND HOLDERS

- A. Acceptable manufacturers and respective catalog numbers:
 

	<u>Ives</u>	<u>Hager</u>	<u>Burns</u>
Wrought Concave Wall Bumper	WS406CCV	236W	575
Automatic Wall Holder	WS40	326W	533
- B. Furnish a stop or holder for all doors. Furnish floor stops or hinge pin stops only where specifically specified.
- C. Where wall stops are not applicable, furnish overhead stops.
- D. Do not provide holder function for labeled doors.

**2.10 WEATHERSTRIP, GASKETING**

- A. Acceptable manufacturers and respective catalog numbers:
- |                    | <u>Zero</u> | <u>Pemko</u> | <u>NGP</u> | <u>Reese</u> |
|--------------------|-------------|--------------|------------|--------------|
| Weatherstrip       | 429         | 2891_PK      | 700NA      | 755          |
| Adhesive Gasket    | 188         | S88          | 5050       | 797          |
| Meeting Edge Seals | 8193        | 18041        | 9605       | 959          |
| Adhesive Edge Seal | ****        | S771         | 5060       | ****         |
| Sweep w/ drip      | 8198        | 345_N        | C627       | 354          |
| Drip Cap           | 142         | 346          | 16         | R201         |
- B. Weatherstrip and gasketing shall be independently certified by ANSI for compliance with ANSI A156.22 (2005).
- C. Where specified in the hardware groups, furnish the above products unless otherwise detailed in groups.
- D. Provide weatherstripping all exterior doors and where specified.
- E. Provide intumescent and other required edge sealing systems as required by individual fire door listings to comply with positive pressure standards UL 10C.
- F. Provide Zero 188 smoke gaskets at all fire rated doors and smoke and draft control assemblies.
- G. Provide gasketing for all meeting edges on pairs of fire doors. Gasketing shall be compatible with astragal design provided by door supplier as required for specific fire door listings.

**2.11 THRESHOLDS**

- A. Acceptable manufacturers and respective catalog numbers:
- |                   | <u>Zero</u> | <u>Pemko</u> | <u>NGP</u> | <u>Reese</u> |
|-------------------|-------------|--------------|------------|--------------|
| Saddle Thresholds | 8655        | 171          | 425        | S205         |
- B. Thresholds shall be independently certified by ANSI for compliance with ANSI A156.21 (2001).
- C. Hardware supplier shall verify all finish floor conditions and coordinate proper threshold as required to insure a smooth transition between threshold and interior floor finish.
- D. Threshold Types:
1. Unless otherwise specified, provide saddle threshold similar to Zero 8655 for all exterior openings with an interior floor finish less than or equal to 1/4" in height.
  2. Unless otherwise specified, provide half saddle threshold similar to Zero 1674 for all exterior openings with an interior floor finish greater than 1/4" in height. Threshold height shall match thickness of interior floor finish.

**2.12 FINISHES AND BASE MATERIALS**

- A. Unless otherwise indicated in the hardware groups or herein, hardware finishes shall be applied over base metals as specified in the following finish schedule:

<u>HARDWARE ITEM</u>	<u>BHMA FINISH AND BASE MATERIAL</u>
Butt Hinges: Exterior, or Non-Ferrous	630 (US32D - Satin Stainless Steel)
Butt Hinges: Interior	652 (US26D - Satin Chromium)
Continuous Hinges	630 (US32D - Satin Stainless Steel)
Flush Bolts	626 (US26D - Satin Chromium)
Exit Devices	626 (US26D - Satin Chromium)
Locks and Latches	626 (US26D - Satin Chromium)
Pulls and Push Plates/Bars	630 (US32D - Satin Stainless Steel)
Coordinators	600 (Prime painted or mill alum.)
Closers	689 (Powder Coat Aluminum)

Protective Plates	630 (US32D - Satin Stainless Steel)
Overhead Stops	630 (US32D - Satin Stainless Steel)
Wall Stops and Holders	630 (US32D - Satin Stainless Steel)
Thresholds	628 (Mill Aluminum)
Weather-strip, Sweeps Drip Caps (wood and hollow metal doors)	Aluminum Anodized
Weather-strip, Sweeps Drip Caps (aluminum doors)	Match finish of aluminum doors.
Magnetic Holders	Sprayed Aluminum
Magnetic Locks	628 (US28)
Miscellaneous	626 (US26D - Satin Chromium)

## 2.13 DOOR POSITION SWITCHES

- A. Acceptable manufacturers, subject to compliance with specified requirements, acceptable manufacturers and products are:
1. Detex MS-2049F
  2. Locknetics 679 Series
  3. Sargent 3287
  4. SDC, MC-4
  5. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.14 KEYING

- A. Acceptable manufacturers and respective catalog numbers:
1. Schlage: Everst Primus (MATCH OWNER EXISTING).
- B. Provide all locks and cylinders utilizing a patented keyway to prevent manufacturing and distribution of aftermarket key blanks by anyone other than factory authorized dealers.
- C. All locks under this section shall be keyed as directed by the owner to a new Patented Master Key System.
- D. Keying shall be by lock manufacturer where permanent records shall be kept.
- E. Furnish a total of 2 keys per cylinder. Actual cut keys to be determined by owner.
- F. Master keys and control keys to be delivered by registered mail to the owner. Change keys shall be delivered in a set up key cabinet. Construction keys shall be delivered to the contractor.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Prior to installation of hardware, installer shall examine door frame installation to insure frames have been set square and plumb. Installer shall examine doors, door frames, and adjacent wall, floor, and ceiling for conditions, which would adversely affect proper operation and function of door assemblies. Do not proceed with hardware installation until such deficiencies have been corrected.

### 3.02 INSTALLATION

- A. Before hardware installation, general contractor/construction manager shall coordinate a hardware installation seminar with a 1 week notice to all parties involved. The seminar is to be conducted on the installation of hardware, specifically of locksets, closers, exit devices, continuous hinges and overhead stops. Manufacturer's representative of the above products to present seminar. Seminar to be held at the job site and attended by installers of hardware (including low voltage hardware) for aluminum, hollow metal and wood doors. Training to include use of installation manuals, hardware schedule, templates and physical products samples.

- B. Install all hardware in accordance with the approved hardware schedule and manufacturer's instructions for installation and adjustment.
- C. Set units level, plumb and true to the line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accord with industry standards.
- E. Drill appropriate size pilot holes for all hardware attached to wood doors and frames.
- F. Shim doors as required to maintain proper operating clearance between door and frame.
- G. Unless otherwise specified, locate all hardware in accordance with the recommended locations for builders hardware for standard doors and frames as published by the Door and Hardware Institute.
- H. Use only fasteners supplied by or approved by the manufacturer for each respective item of hardware.
- I. Mortise and cut to close tolerance and conceal evidence of cutting in the finished work.
- J. Conceal push and pull bar fasteners where possible. Do not install through bolts through push plates.
- K. Install hardware on UL labeled openings in accordance with manufacturer's requirements to maintain the label.
- L. Apply self-adhesive gasketing on frame stop at head AND latch side and on rabbet of frame at hinge side.
- M. Install hardware in accordance with supplemental "S" label instructions on all fire rated openings.
- N. Install wall stops to contact lever handles or pulls. Do not mount wall stops on casework, or equipment.
- O. Where necessary, adjust doors and hardware as required to eliminate binding between strike and latchbolt. Doors should not rattle.
- P. Overhead stops used in conjunction with electrified hold open closers shall be templated and installed to coincide with engagement of closer hold open position.
- Q. Install door closers on corridor side of lobby doors, room side of corridor doors, and stair side of stairways.
- R. Adjust spring power of door closers to the minimum force required to insure exterior and fire rated doors will consistently close and latch doors under existing conditions. Adjust all other door closers to insure opening force does not to exceed 5 pounds.
- S. Adjust "sweep", "latch", and "back check" valves on all door closers to properly control door throughout the opening and closing cycle. Adjust total closing speed as required to comply with all applicable state and local building codes.
- T. Install "hardware compatible" (bar stock) type weatherstripping continuously for an uninterrupted seal. Adjust templating for parallel arm door closers, exit devices, etc., as required to accommodate weatherstripping.
- U. Unless otherwise specified or detailed, install thresholds with the bevel in vertical alignment with the outside door face. Notch and closely fit thresholds to frame profile. Set thresholds in full bed of sealant.

- V. Compress sweep during installation as recommended by sweep manufacturer to facilitate a water resistant seal.
- W. Deliver to the owner 1 complete set of installation and adjustment instructions, and tools as furnished with the hardware.

**3.03 FIELD QUALITY CONTROL**

- A. After installation has been completed, the hardware supplier and manufacturer’s representative for locksets, door closers, exit devices, and overhead stops shall check the project and verify compliance with installation instructions, adjustment of all hardware items, and proper application according to the approved hardware schedule. Hardware supplier shall submit a list of all hardware that has not been installed correctly.
- B. After installation has been completed, the hardware supplier and manufacturer’s representative shall meet with the owner to explain the functions, uses, adjustment, and maintenance of each item of hardware. Hardware supplier shall provide the owner with a copy of all wiring diagrams. Wiring diagrams shall be opening specific and include both a riser diagram and point to point diagram showing all wiring terminations.

**3.04 ADJUSTMENT AND CLEANING**

- A. At final completion, and when H.V.A.C. equipment is in operation, installer shall make final adjustments to and verify proper operation of all door closers and other items of hardware. Lubricate moving parts with type lubrication recommended by the manufacturer.
- B. All hardware shall be left clean and in good operation. Hardware found to be disfigured, defective, or inoperative shall be repaired or replaced.

**3.05 HARDWARE SCHEDULE**

- A. The following schedule of hardware groups are intended to describe opening function. The hardware supplier is cautioned to refer to the preamble of this specification for a complete description of all materials and services to be furnished under this section.

**SET 1 DOOR(S): 100, 104**

<u>QTY</u>	<u>DESCRIPTION</u>	<u>CATALOG NUMBER</u>	<u>MFR</u>
1 EA	HINGE	5BB1 4.5 X 4.5	IVE
1 EA	PANIC HARDWARE	CD-99-NL-OP	VON
1 EA	IC CYLINDER	AS REQUIRED	SCH
1 EA	DOOR PULL	VR910-NL	IVE
1 EA	SURFACE CLOSER	4050A HEDA	LCN
1 EA	RAIN DRIP	142	ZER
1 EA	WEATHERSTRIP	429	ZER
1 EA	DOOR SWEEP W/DRIP	8198	ZER
1 EA	THRESHOLD	8655	ZER
1 EA	DOOR POSITION SWITCH	679-05HM	SCH

**SET 2 DOOR(S): 103**

<u>QTY</u>	<u>DESCRIPTION</u>	<u>CATALOG NUMBER</u>	<u>MFR</u>
1 EA	HINGE	5BB1 4.5 X 4.5	IVE
1 EA	PANIC HARDWARE	CD-99-NL-OP	VON
1 EA	KEYED REMOVABLE MULLION	KR4954	VON
1 EA	IC CYLINDER	AS REQUIRED	SCH
1 EA	DOOR PULL	VR910-NL	IVE
1 EA	SURFACE CLOSER	4050A HEDA	LCN
1 EA	RAIN DRIP	142	ZER
1 EA	WEATHERSTRIP	429	ZER



1	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	8655	ZER
1	EA	DOOR POSITION SWITCH	679-05HM	SCH

**SET 3 DOOR(S): 102**

<u>QTY</u>		<u>DESCRIPTION</u>	<u>CATALOG NUMBER</u>	<u>MFR</u>
1	EA	HINGE	5BB1 4.5 X 4.5	IVE
1	EA	PRIVACY LOCK	ND40S SPA	SCH
1	EA	SURFACE CLOSER	4011 REG SRT TEL CYL	LCN
1	EA	PROTECTION PLATE	K1050 10" X 34" 4BE CSK	RO
1	EA	WALL STOP	WS406/407CCV	IVE
3	EA	SILENCER	SR64	IVE

**SET 4 DOOR(S): 105**

<u>QTY</u>		<u>DESCRIPTION</u>	<u>CATALOG NUMBER</u>	<u>MFR</u>
1	EA	HINGE	5BB1 4.5 X 4.5	IVE
1	EA	PANIC HARDWARE	CD-99-NL-OP	VON
1	EA	IC CYLINDER	AS REQUIRED	SCH
1	EA	DOOR PULL	VR910-NL	IVE
1	EA	SURFACE CLOSER	4050A HEDA	LCN
1	EA	RAIN DRIP	142	ZER
1	EA	WEATHERSTRIP	429	ZER
1	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	8655	ZER
1	EA	DOOR POSITION SWITCH	679-05HM	SCH

**END OF SECTION**

## SECTION 08 88 13

### FIRE RATED GLASS AND FRAMING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes:
  - 1. Fire rated glazing and framing systems for installation as windows in interior openings.
- B. Related Sections:
  - 1. Section 07 84 00 - Firestopping.
  - 2. Section 07 92 00 - Joint Sealants

##### 1.02 REFERENCES

- A. American Architectural Manufacturers Association (AAMA)
  - 1. AAMA 2605 -2005 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
  - 2. 611 - Anodized Architectural Aluminum
- B. American Society for Testing and Materials (ASTM):
  - 1. Fire safety related:
    - a. ASTM E119: Methods for Fire Tests of Building Construction and Materials.
    - b. ASTM E2110-1: Standard Test for Positive Pressure of Fire Tests of Window Assemblies.
    - c. ASTM E163 Methods for Fire Tests of Window Assemblies.
    - d. ASTM A1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2007.
    - e. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2006b.
  - 2. A36 - Carbon Structural Steel
  - 3. A123 - Zinc Coatings on Iron and Steel Products
  - 4. A153 - Zinc Coatings on Iron and Steel Hardware
  - 5. A240 - Chromium and Chromium-Nickel Stainless Steel Plate
  - 6. B209 - Aluminum and Aluminum Alloy Sheet and Plate
  - 7. B221 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire Profiles, and Tubes
  - 8. B429 - Aluminum Alloy Extruded Structural Pipe and Tube
  - 9. C1401, Appendix X2 - Destructive Test Method A to test Structural Sealant Compatibility and Adhesion
  - 10. E84 - Surface Burning Characteristics
  - 11. E699 - Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluation of Building Components
  - 12. C542 - Lock-Strip Gaskets
  - 13. C716 - Installation of Lock-Strip Gaskets
  - 14. Heat-Treated Flat Glass
- C. American Welding Society (AWS)
  - 1. AWS D1.3 - Structural Welding Code - Sheet Steel; 2007
- D. National Fire Protection Association (NFPA):
  - 1. NFPA 80: Fire Doors and Windows.
  - 2. NFPA 251: Fire Tests of Building Construction & Materials.
  - 3. NFPA 252: Fire Tests of Door Assemblies.
  - 4. NFPA 257: Fire Test of Window Assemblies.

- E. Underwriters Laboratories, Inc. (UL):
  1. UL 9: Fire Tests of Window Assemblies.
  2. UL 10 B: Fire Tests of Door Assemblies.
  3. UL 10 C: Positive Pressure Fire Tests of Window & Door Assemblies.
  4. UL 263: Fire tests of Building Construction and Materials.
- F. American National Standards Institute (ANSI):
  1. ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings
- G. Consumer Product Safety Commission (CPSC):
  1. CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials.
- H. I. Glass Association of North America (GANA)
  1. GANA - Glazing Manual.
  2. FGMA - Sealant Manual.

### 1.03 DEFINITIONS

- A. Manufacturer: A firm that produces primary glass, fabricated glass or framing as defined in referenced glazing publications.

### 1.04 SUBMITTALS

- A. Submit in accordance with Section 01 33 00.
- B. Product Data:
  1. Technical Information: Submit latest edition of manufacturer's product data providing product descriptions, technical data, Underwriters Laboratories, Inc. listings and installation instructions.
- C. Shop Drawings:
  1. Include plans, elevations and details of product showing component dimensions; framing opening requirements, dimensions, tolerances, and attachment to structure
  2. Provide templates for the location of embeds and anchor locations required for any adjoining work (if applicable).
- D. Glazing Schedule: Use same designations indicated on drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- E. Warranties: Submit manufacturer's warranty.
- F. Certificates of compliance from glass and glazing materials manufacturers attesting that glass and glazing materials furnished for project comply with requirements.
  1. Separate certification will not be required for glazing materials bearing manufacturer's permanent label designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authority having jurisdiction.

### 1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualifications according to
  1. International Accreditation Service for a Type A Third-Party Inspection Body (Field Services ICC-ES Third-Party Inspections Standard Operating Procedures, 00-BL-S0400 and S0401)
  2. International Accreditation Service for Testing Body-Building Materials and Systems
    - a. Fire Testing
      - 1) ASTM Standards E 119
      - 2) CPSC Standards 16 CFR 1201
      - 3) NFPA Standards 251, 252, 257
      - 4) UL Standards 9, 10B, 10C, 1784, UL Subject 63
      - 5) BS 476; Part 22: 1987

- 6) EN 1634-1
- 7) CAN Standards S 101, S 104, S 106

- B. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are classified and labeled by UL, for fire ratings indicated, based on testing according to NFPA 257 and UL 9.
- C. Fire-Rated Wall Assemblies: Assemblies complying with ASTM E119 that are classified and labeled by UL, for fire ratings indicated, based on testing in accordance with UL 263, ASTM E119.
- D. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by Underwriters Laboratories® maintaining a current listing or certification. Label assemblies in accordance with limits of manufacturer's listing.

## **1.06 DELIVERY, STORAGE AND HANDLING**

- A. Deliver, store and handle under provisions specified by manufacturer.

## **1.07 PROJECT CONDITIONS**

- A. Field Measurements:
  - 1. Check openings by field measurement before fabrication to ensure proper fitting of work; show measurements on final Shop Drawings.
  - 2. Coordinate fabrication schedule with construction progress to avoid delay in the work.
  - 3. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit.
- B. Storage and Protection:
  - 1. Protect installed materials from damage by adjacent work.
  - 2. Protect against scratching and falling debris or equipment.
  - 3. Damages resulting from work: Immediately repair or replace as necessary to acceptance of Architect at no additional cost to Owner.
- C. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## **1.08 WARRANTY**

- A. Provide manufacturer's standard 5-year warranty of material and workmanship, including reglazing, to repair or replace defective units at no cost to Owner.
- B. Failures: Include, but are not limited to:
  - 1. Structural failures including, but not limited to, excessive deflection.
  - 2. Faulty operation of door hardware supplied by this section.
  - 3. Noise or vibration caused by thermal movements.
  - 4. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 5. Adhesive or cohesive sealant failures.
  - 6. Water leakage through fixed glazing and framing areas.
  - 7. Failure of operating components to function properly.
- C. Finish warranty agreeing to repair or replace components on which finish fails:
  - 1. Class II anodized finish: Provide manufacturer's 2-year warranty.
- D. Provide 10-year written glass warranty, beginning at date of substantial completion, covering labor, materials for replacement of spontaneous failure of all tempered glass used on Project.
- E. For any glass requiring replacement under this warranty, provide a new minimum 5-year warranty commencing at date of acceptance of replacement glass by Owner and Architect.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Manufacturer Fire Rated Glazing Material:
  - 1. Standard of Quality: Unless indicated otherwise, design is based on products of: "Pilkington Pyrostop®" fire-rated glazing as manufactured by the Pilkington Group and distributed by Technical Glass Products, 8107 Bracken Place SE, Snoqualmie, WA 98065 (800-426-0279) fax (800-451-9857) e-mail [sales@fireglass.com](mailto:sales@fireglass.com), web site <http://www.fireglass.com>
  - 2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Superlite II-XL, by Safti [www.safti.com](http://www.safti.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- B. Manufacturer Fire Rated Frame System:
  - 1. Standard of Quality: Unless indicated otherwise, design is based on products of: "Fireframes® Aluminum Series" fire-rated frame system as manufactured and supplied by Technical Glass Products, 8107 Bracken Place SE, Snoqualmie, WA 98065 (800-426-0279) fax (800-451-9857) e-mail [sales@fireglass.com](mailto:sales@fireglass.com) web site <http://www.fireglass.com>
  - 2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. GPX Architectural Series, by Safti [www.safti.com](http://www.safti.com)
    - b. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

### 2.02 PERFORMANCE REQUIREMENTS

- A. System Description:
  - 1. Steel fire-rated glazed wall and/or window system, dual aluminum cover cap format
    - a. Face widths available:
      - 1) Up to 2 1/2-inch.
      - 2) Custom extruded aluminum cover caps.
    - b. Duration - Windows Capable of providing a fire rating for 60 minutes.

### 2.03 MATERIALS - GLASS

- A. Fire Rated Glazing: UL listed.
  - 1. Clear.
- B. Logo: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.
- C. Heat-Treated Glass Products:
  - 1. ASTM C1048; Type I (transparent flat glass).
  - 2. Quality Q3 (glazing select).
  - 3. Tempered Glass: Provide tempered float glass required by safety of CPSC 16 CFR 1201, other codes and regulations, where safety glass is indicated.
  - 4. Clear.
- D. Glazing Accessories: Manufacturer's standard compression gaskets, standoff, spacers, setting blocks and other accessories necessary for a complete installation.

### 2.04 MATERIALS –FIRE RATED ALUMINUM FRAMES

- A. Aluminum Framing System 60 min. AND 120 min.
  - 1. Steel Frame - Internal tube steel framing shall conform to ASTM A501. Formed steel retainers shall be galvanized conforming to ASTM A527.

2. Aluminum Trim - Aluminum Alloy 5052 Supplied with the steel framing members. Nom. 2 inches (50.8 mm) wide with a nom. depth of 1.54 inches (39 mm) with lengths cut according to glazing size.
3. Insulation: The framing system shall insulate against the effects of fire, smoke and heat transfer from either side. The perimeter of the framing system to the rough opening shall be firmly packed with mineral wool fire stop insulation or appropriately rated intumescent sealant.
4. Fasteners - as recommended by the manufacturer.
5. Glazing accessories - as recommended by the manufacturer.

## **2.05 FABRICATION**

- A. Storefront Framing System:
  1. Fabricate aluminum entrance and storefront components to designs, sizes and thicknesses indicated and to comply with indicated standards.
  2. See Drawings for variable dimensions, with maximum and minimum dimensions required to achieve design requirements and coordination with other work.
  3. Provide for flush glazing storefront from the exterior on all sides without projecting stops.
  4. Shop-fabricate and preassemble frame components where possible.
  5. Form aluminum shapes before finishing.
  6. Provide storefront frame sections without exposed seams.
  7. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
  8. Perform fabrication operations, including cutting, fitting, welding forming, drilling and grinding of metal work to prevent damage to exposed finish surfaces.
  9. Fabricate components that, when assembled, have the following characteristics:
    - a. Profiles that are sharp, straight, and free of defects or deformations.
    - b. Accurately fitted joints with ends coped or mitered.
    - c. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- B. Field glaze frame assemblies.

## **2.06 FINISHES, GENERAL**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish frames after assembly.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable. Noticeable variations in the same piece are not acceptable.

## **2.07 FINISHES**

- A. Anodized Finishes
  1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Retain finishes below to suit Project. If retaining more than one, indicate location of each on Drawings or by inserts. Revise mechanical finish if custom finish is required and availability is verified.
  3. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

## **2.08 ACCESSORY MATERIALS**

- A. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Site Verification of Conditions: Examine substrates and members to which the work of this section attaches or adjoins prior to frame installation are acceptable for product installation in accordance with manufacturer's instructions. Provide openings plumb, square and within allowable tolerances. The manufacturer recommends 3/8-inch shim space at all walls.
- B. Notify Architect of any conditions which jeopardize the integrity of the proposed fire wall system.
- C. Do not proceed until such conditions are corrected.

### **3.02 INSTALLATION**

- A. See Manufacturer's Installation Manual

### **3.03 REPAIR AND TOUCH UP**

- A. Anodized Finishes
  - 1. Protect the anodized finish from harsh chemicals such as concrete/mortar or muriatic acid/brick wash. If reasonable care is taken during handling and high and low pH chemicals can be avoided, repair and/or touch-up of an anodize finish will not be needed.
  - 2. Some rub marks on an anodized surface can be removed with a mild abrasive pad such as a Scotch-Brite pad prior to touch up painting.
  - 3. Touch-up paint should be used even more sparingly over anodize. Only the visible raw aluminum in the scratch or gouge should be touched up with a matching paint.
- B. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged.

### **3.04 PROTECTION AND CLEANING**

- A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
  - 1. Do not clean with astringent cleaners. Use a clean "grit free" cloth and a small amount of mild soap and water or mild detergent.
  - 2. Do not use any of the following:
    - a. Steam jets.
    - b. Abrasives.
    - c. Strong acidic or alkaline detergents, or surface-reactive agents.
    - d. Detergents not recommended in writing by the manufacturer.
    - e. Do not use any detergent above 77 degrees F.
    - f. Organic solvents including but not limited to those containing ester, ketones, alcohols, aromatic compounds, glycol ether, or halogenated hydrocarbons.
    - g. Metal or hard parts of cleaning equipment must not touch the glass surface.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.
- C. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

**END OF SECTION**

## SECTION 09 22 00

### NON-STRUCTURAL METAL FRAMING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide non-load-bearing steel framing members for the following applications:
  - 1. Interior Framing Systems (supports for partition walls, furring, etc.):
    - a. Studs (1 foot-4 inches on center unless otherwise noted).
    - b. Runners.
    - c. Blocking:
      - 1) Wall hung items.
      - 2) Grab bars.
  - 2. Interior Suspension Systems (supports for ceilings, suspended soffits, etc.):
    - a. Ceiling support materials:
      - 1) Main runners.
      - 2) Furring members.
      - 3) Angle-type hangers.
      - 4) Hanger anchorage device.
      - 5) Hanger wire.
    - b. Accessories.
- B. Related Sections:
  - 1. Section 09 29 00 - Gypsum Board
  - 2. Section 09 30 00 - Tiling

##### 1.02 REFERENCES

- A. ASTM:
  - 1. A641 - Standard for Zinc-Coated Carbon Steel Wire
  - 2. C645 - Standard for Non-Structural Steel Framing
  - 3. C754 - Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
  - 4. C841 - Installation of Interior Lathing and Furring
  - 5. C840 - Application and Finishing of Gypsum Board
  - 6. E90 - Test for Airborne Sound Transmission
  - 7. E119 - Fire Tests of Building Construction Materials
  - 8. E413 - Rating Sound Insulation

##### 1.03 DEFINITIONS

- A. UL: Underwriters Laboratories.

##### 1.04 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.
- C. Quality Assurance/Control Submittals:
  - 1. Test Reports: UL reports indicating approval for use in fire rated assemblies.



## 1.05 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide metal support system units made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
- B. Qualifications:
  - 1. Manufacturer: 5 years' experience in the manufacture of metal support systems.
  - 2. Contractor: 3 years' experience in the installation of metal support systems.
  - 3. Personnel: For actual installation of metal support systems, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.

## 1.06 PROJECT CONDITIONS

- A. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## 1.07 SEQUENCING

- A. Carefully coordinate requirements for support backing of items to be mounted on finished walls and ceilings.
- B. Carefully coordinate requirements for pipes, ducts, cabling, other services in soffits, plenums, other items designed to be housed within partition, wall, or soffit system.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
  - 1. Steel Studs and Furring Materials:
    - a. Dietrich Industries, Inc., Pittsburgh, PA [www.dietrichmetalframing.com](http://www.dietrichmetalframing.com)
    - b. National Gypsum [www.nationalgypsum.com](http://www.nationalgypsum.com)
    - c. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
  - 2. Grid Suspension System for Ceilings:
    - a. Armstrong World Industries [www.armstrong.com](http://www.armstrong.com)
    - b. Chicago Metallic Corporation [www.chico-metallic.com](http://www.chico-metallic.com)
    - c. USG Corporation [www.usg.com](http://www.usg.com)

### 2.02 COMPONENTS

- A. Steel Studs and Furring Materials:
  - 1. Studs and Runners:
    - a. Main runners: Steel channels with rust inhibitive paint finish, hot or cold rolled.
    - b. Screw type, drywall studs formed of galvanized steel, conforming to ASTM C645.
    - c. Size:
      - 1) 20-gage nominal, 3-5/8-inch studs, except as indicated on Drawings; with cut-outs for pipe and conduit.
      - 2) 20-gage nominal studs at 16 inches on center at mortar (tile) backer board and cement backer board at exterior soffit system.
      - 3) 20-gage behind large wall-hung cabinets.
      - 4) 16-gage at each side of door jambs.
  - 2. Carrying Channels: Cold-rolled, commercial-steel sheet with base-metal thickness of 0.0538-inch and minimum 1/2-inch-wide flanges.
  - 3. Furring Channels:
    - a. Cold-rolled channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges, 3/4-inch-deep.

- b. Steel studs: ASTM C645.
  - c. Hat-shaped, rigid furring channels: ASTM C645, 7/8-inch-deep.
  - d. Resilient furring channels:
    - 1) 1/2-inch-deep.
    - 2) Place 24 inches on center.
    - 3) Designed to reduce sound transmission.
    - 4) Asymmetrical.
  - e. Z-shaped furring:
    - 1) Slotted or nonslotted web.
    - 2) Face flange of 1-1/4 inches.
    - 3) Wall attachment flange of 7/8-inch.
    - 4) Minimum bare-metal thickness of 0.0179 inch.
    - 5) Depth required to fit insulation thickness.
- B. Ceiling Support Materials:
- 1. Direct-hung system composed of main beams and cross-furring members that interlock.
  - 2. Size ceiling support components to comply with ASTM C754, unless indicated otherwise.
  - 3. Install 16 inches on center maximum for exterior soffits (20 gage minimum).
  - 4. Tie Wire:
    - a. ASTM A641, Class 1.
    - b. Zinc coating, soft temper.
    - c. 0.0625-inch-diameter wire, or double strand of 0.0475-inch-diameter wire.
  - 5. Wire Hangers:
    - a. Galvanized steel wire.
    - b. ASTM A641, Class 1.
    - c. Zinc coating, soft temper, 0.162-inch-diameter.
  - 6. Flat Hangers: Steel sheet, in size indicated on Drawings.
    - a. Angle-type hangers: Not less than 7/8-inch by 7/8-inch by 16-gage galvanized steel formed angles.
    - b. Bolted connections and 5/16-inch-diameter bolts.
- C. Hanger Anchorage Devices:
- 1. ASTM A641.
  - 2. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
  - 3. Fasteners for Concrete: Corrosion-resistant screws, clips, bolts, cast-in-place concrete inserts or other devices applicable to indicated method of structural anchorage for ceiling hangers, whose suitability for use intended has been proven by certified test data.
    - a. Size devices for 3 times calculated load supported except size direct pull-out concrete inserts for 5 times calculated loads.
  - 4. Furring Anchorage: 16-gage galvanized wire ties, manufacturer's standard wire-type clips, bolts, nails, screws recommended by furring manufacturers and complying with ASTM C754.
- D. Accessories:
- 1. Clips, Screws, and Other Accessories: Manufacturer's standard type for intended use.
  - 2. Acoustical Sealant: Non-hardening, flexible, latex acrylic.
  - 3. Other Materials: Not specifically described but required for complete and proper installation, to be new, first quality of respective kinds, subject to acceptance of Engineer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.

- B. Verification of Conditions:
  - 1. With Installer present, examine areas and substrates, including welded hollow-metal frames, cast-in anchors, and structural framing for compliance with requirements and other conditions affecting performance.
  - 2. Verify that metal support systems may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies:
  - 1. Immediately notify Engineer.
  - 2. Do not proceed with installation in areas of discrepancy until fully resolved.
  - 3. Commencement of installation signifies acceptance of surface conditions.

### 3.02 PREPARATION

- A. Suspended Assemblies:
  - 1. Coordinate installation with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  - 2. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### 3.03 INSTALLATION

- A. Installation Standards:
  - 1. All Work of This Section: Comply with ASTM C754.
  - 2. Gypsum Board Assemblies: Comply with ASTM C840.
- B. Steel Studs and Furring Members:
  - 1. Extend steel stud partitions to structure above where indicated on Drawings
  - 2. Securely attach floor runners with concrete stub nails or powder-driven anchors spaced not over 24 inches on center.
  - 3. Set runners in two 1/4-inch beads of specified acoustical sealant.
  - 4. Attach runners to structure above with connection allowing for structure movement.
  - 5. Do not bridge building expansion joints.
  - 6. Studs:
    - a. Anchor studs to runner channels with screws or other positive fasteners; double studs at hollow metal frames.
    - b. Securely anchor to jamb and head anchor clips at hollow metal frames with screws or bolts.
    - c. Install runner track with web and flanges bent down at each end across head of hollow metal frames.
    - d. Screw each flange to vertical studs.
    - e. Install jack studs above frame.
    - f. Install supplementary framing, blocking and bracing at terminations in the work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings and similar construction.
    - g. Comply with details indicated and with recommendations of gypsum board manufacturer, or if none available, with "*Gypsum Construction Handbook*," published by United States Gypsum Company.
- C. Ceiling Support Suspension Systems:
  - 1. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
  - 2. Hangers:
    - a. Secure hangers structural support by connecting directly to structure where possible, otherwise connect to inserts, clips, or other anchorage devices or fasteners as indicated.
    - b. Do not attach hangers to steel roof deck.
    - c. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
    - d. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
    - e. Do not connect or suspend steel framing from ducts, pipes, or conduit.

3. Spacing:
    - a. Space main runners 4 feet on center and space hangers 4 feet on center along runners, except as otherwise indicated.
    - b. Locate main runners within 6 inches of parallel walls, space not more than 4 feet on center.
    - c. Keep ends of main runners at least 1 inch away from walls.
    - d. Level main runners to tolerance of 1/4 inch in 12 feet, measured both lengthwise on each runner and transversely between parallel runners.
  4. Furring Members:
    - a. Wire-tie or clip to main runners and to other structural supports as indicated.
    - b. Space 24 inches on center, except as otherwise indicated.
    - c. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel.
    - d. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
  5. Grillage:
    - a. Where hanger spacing and spans exceed specified spans, use hangers with larger capacity, larger main runners, or additional reinforcing members, hangers, stiffening, or bracing as necessary to support loads without exceeding specified deflection.
    - b. Make provision for control, expansion joints as indicated or otherwise required to avoid damage to gypsum board ceilings.
  6. Auxiliary Framing: Install at termination of ceiling and at openings for light fixtures and similar work, as required for support of both gypsum base and other work indicated for support.
- D. Installation Tolerance: Install suspension systems that are level to within 1/8-inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

### 3.04 INSTALLATION OF FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks (runners) at floors and overhead supports.
- D. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings.
- E. Continue framing around ducts penetrating partitions above ceiling.
  1. Slip-type head joints: Where framing extends to overhead structural supports, install to product joints at tops of framing systems that prevent axial loading of finished assemblies.
- F. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames.
  1. Install runner track section (for cripple studs) at head and secure to jamb studs.
  2. Install 2 studs at each jamb, unless otherwise indicated.
  3. Install cripple studs at head adjacent to each jamb stud, with minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
  4. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
- G. Other Framed Openings:
  1. Frame same as door openings, unless otherwise indicated.
  2. Install framing below sills of openings to match framing required above door heads.
- H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### **3.05 MISCELLANEOUS CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Where main runners, cross runners are interrupted by light fixtures, grilles, registers or other openings: Install additional runners to frame openings.
  - 2. Reinforce grillage as necessary to support light fixtures, grilles, registers, other items mounted in ceiling.
  
- B. Site Tolerances:
  - 1. Vertically: 1 in 500.
  - 2. Horizontally: 1 in 200.
  - 3. Ceilings: Maximum allowable deflection of 1/360 of span.

**END OF SECTION**

## SECTION 09 29 00

### GYPSUM BOARD

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Gypsum drywall:
    - a. WR gypsum board.
  - 2. Corner beads and trim.
    - a. Metal.
    - b. Prefinished matching trim.
  - 3. Joint treatment.
  - 4. Drywall accessories including, but not limited to:
    - a. Fasteners.
    - b. Adhesives.
- B. Related Sections:
  - 1. Section 06 10 53 - Miscellaneous Rough Carpentry

##### 1.02 REFERENCES

- A. ASTM:
  - 1. C557 - Standards for Adhesives for Fastening Wallboard to Wood Framing
  - 2. C840 - Application and Finishing of Gypsum Board
  - 3. C1002 - Standard for Steel Self-Piercing Tapping Screws for Application of Gypsum Panels
  - 4. C1396 - Standard for Gypsum Board
  - 5. D217 - Cone Penetration of Lubricating Grease
  - 6. D3273 - Test for Resistance to Growth of Mold on the Surface of Interior Coatings
  - 7. E84 - Surface Burning Characteristics of Building Materials
  - 8. E119 - Fire Tests of Building Construction Materials
- B. Gypsum Association - Levels of Gypsum Board Finish (GA-214-Latest Edition)

##### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.

##### 1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide drywall systems units made of components of standard construction furnished by one manufacturer as coordinated assemblies.
- B. Qualifications:
  - 1. Manufacturer: 5 years' experience in the manufacture of drywall systems.
  - 2. Contractor: 3 years' experience in the installation of drywall systems.
  - 3. Personnel: For actual installation of drywall systems, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.

## 1.05 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes.
- B. Stack panels flat to prevent sagging.

## 1.06 PROJECT CONDITIONS

- A. Environmental Conditions:
  - 1. Joint Treatment: Control heating, ventilating during finishing operations to ensure maintenance of 55 degrees F minimum temperature.
  - 2. Comply with ASTM C840 or manufacturer's recommendations, whichever are more stringent.
  - 3. Existing Conditions: Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.
- B. Do not install panels that are wet, show moisture damage, or are mold damaged.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. Gypsum Drywall:
  - 1. Standard of Quality: Design is based on products of United States Gypsum Company (USG) [www.usg.com](http://www.usg.com)
  - 2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. G-P Gypsum [www.gp.com/gypsum](http://www.gp.com/gypsum)
    - b. Lafarge, Herndon, VA [www.lafarge-na.com](http://www.lafarge-na.com)
    - c. National Gypsum Company [www.nationalgypsum.com](http://www.nationalgypsum.com)
    - d. Temple, Diboll TX [www.alleghenybmdf.com](http://www.alleghenybmdf.com)
    - e. BPB America [www.bpb-na.com](http://www.bpb-na.com)
    - f. Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- B. Corner Beads and Trim:
  - 1. Metal design is based on Sheetrock brand products of USG [www.usg.com](http://www.usg.com)
  - 2. Resilient furring channel design is based on products of Dalel/Incor [www.daleincor.com](http://www.daleincor.com) or Dietrich [www.dietrichmetalframing.com](http://www.dietrichmetalframing.com)
  - 3. Subject to compliance with requirements, acceptable manufacturers are:
    - a. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

### 2.02 MATERIALS

- A. Panels, General:
  - 1. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Interior Gypsum Drywall:
  - 1. Water Resistant Panels:
    - a. Meet ASTM D3273 for moisture and mold resistance.
    - b. Core: 5/8-inch Type X.
    - c. Long Edges: Tapered.
    - d. Sheetrock Mold Tough.
  - 2. Ceiling Type:
    - a. Greater sag resistance.
    - b. Thickness: 1/2 inch.
    - c. Long Edges: Tapered.

- C. Metal Corner Beads and Trim:
  - 1. Paper faced.
  - 2. Rust resistant.
  - 3. Corner Bead: USG *Dur-A-Bead*.
  - 4. Control Joint: USG *093*.
  - 5. "L" Bead: To match panel thickness.
  
- D. Joint Compound:
  - 1. Interior Gypsum Panels: USG ready-to-use joint compound (taping, topping, general purpose).
  - 2. Do not use all-purpose joint compound in wet areas.
  - 3. Verify formulation is compatible with other compounds applied on previous or for successive coats.
  - 4. Setting Type Mix:
    - a. Abuse resistant.
    - b. Non shrink.
    - c. Rapid setting.
    - d. Cement based.
    - e. Mold and moisture resistant.
    - f. Meets ASTM D3272 and 3274.
  
- E. Drywall Accessories:
  - 1. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
  - 2. Fasteners:
    - a. Comply with ASTM C1002.
    - b. Metal Studs, Furring Strips: *USG Type S* bugle head screws of lengths required.
    - c. Other Fasteners: Screws, clips, fasteners specifically designed for application of gypsum drywall panels.
  - 3. Adhesives:
    - a. Non-bituminous base adhesive recommended by gypsum board manufacturer for type of installation and material to receive gypsum wallboard.
    - b. Conform to ASTM C557.
  - 4. Other Materials: Not specifically described but required for complete, proper installation of gypsum drywall, to be selected by installer subject to acceptance of Engineer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades:
  - 1. Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
  - 2. Examine areas and substrates, with installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
  
- B. Verification of Conditions: Verify that gypsum drywall may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
  
- C. Examine panels before installation. Do not install panels that are wet, moisture damaged, or mold damaged.
  - 1. Indications of damage include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications of mold damage include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
  
- D. Discrepancies: Immediately notify Engineer. Do not proceed with installation in areas of discrepancy until fully resolved.



### 3.02 PREPARATION

- A. Protection: Protect installed work and materials of other trades.

### 3.03 INSTALLATION

- A. Gypsum Drywall:
1. Comply with ASTM C840.
  2. Lay out panels to minimize waste; reuse cutoffs whenever feasible.
  3. Use full-length boards where possible.
  4. Install with true, even surfaces, straight sharp corners, face out.
  5. Do not force into place.
  6. In general, install gypsum board on ceilings before walls.
  7. Cutting:
    - a. Score and break or saw, working from face side.
    - b. Smooth cut ends, edges of panels as necessary to obtain smooth joint.
    - c. Make cut-outs in panels for pipes, fixtures, other small openings by sawing or other method to not fracture core or tear covering, so that plates, escutcheons, trim will cover edges.
  8. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling.
  9. Install flat panels plumb, level, with vertical joints on bearing.
  10. Loosely butt joints to be taped; firmly butt joints to be left untreated.
  11. Stagger end joints, joints between panels to achieve maximum of bridging, minimum of continued joints.
  12. Stagger vertical joints on opposite sides of partitions.
  13. Do not make joints other than control joints at corners of framed openings.
  14. Form control and expansion joints with space between edges of adjoining gypsum panels, where indicated on Drawings or, if not indicated, no more than 20 feet on center.
  15. Attachment:
    - a. Screw to framing.
    - b. For walls with gypsum board applied vertically, space screws 8 inches on center along edges, 12 inches on center.
    - c. For walls with gypsum board applied horizontally and ceiling construction, space screws 12 inches on center.
    - d. Fasten gypsum board beginning at center, work towards outer edges. Hold board firmly against supports while fastening.
    - e. Locate fasteners opposite each other on adjacent ends and edges; locate at edges of boards 3/8 inch to 1/2 inch from edge.
  16. Sealing:
    - a. Seal joints in backer board occurring behind control joints.
    - b. Seal around pipes, ducts, conduit, other items extending through gypsum board partitions or ceilings.
    - c. Seal backs, sides of electrical boxes.
    - d. Seal joints, cut edges, nail and screw heads, punctures in water-resistant gypsum backing board with waterproofing sealant recommended by gypsum board manufacturer.
- B. Trim:
1. Drawings are not intended to show all trim required. Carefully inspect Drawings and verify with Engineer precise locations, types of trim to be used.
  2. Installation:
    - a. Follow manufacturer's installation instructions to validate lifetime warranty and replacement costs.
    - b. Install corner reinforcing at external corners, install casing beads where gypsum board abuts other materials.

### 3.04 TAPING AND FINISHING

- A. General:
  - 1. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
  - 2. Promptly remove residual joint compound from adjacent surfaces.
  - 3. Prefill open joints, rounded or beveled edges, and damaged surface areas.
  - 4. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
  
- B. Finish:
  - 1. Tool joints as smoothly as possible to minimize sanding and dust.
  - 2. Protect workers, building occupants, and HVAC systems from gypsum dust.
  - 3. Level 5 with Primer Surfer, as specified by GA-214-90.
    - a. First coat:
      - 1) Spread compound evenly over joints, using suitable tools designed for purpose. Fill joint recesses, metal trim.
      - 2) Center reinforcing tape on joint, press into fresh compound, wiping down with sufficient pressure to remove excess compound but leaving sufficient compound under tape for proper bond.
      - 3) Feather edges, leave surface free from blisters, tape wrinkles.
      - 4) Apply compound to fastener recesses, leaving flush with adjacent surfaces.
      - 5) Fold reinforcing tape along its centerline, apply to interior angles, following same procedure as for joints.
    - b. Second and third coat:
      - 1) Apply coat to joints, feathering approximately 3 inches beyond edges of tape. Apply to fastener recesses; allow to dry.
    - c. Fourth and fifth coat:
      - 1) Apply coat, feathering approximately 2 inches beyond second coat.
      - 2) Coat fastener recesses, metal trim, interior angles; allow to dry.
      - 3) Carefully sand to uniformly smooth surface completely free from irregularities visible to unaided eye at distance of 5 feet.

### 3.05 CLEANING AND PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
- C. Do not allow accumulation of scraps and debris arising from Work of this Section.
- D. Maintain premises in neat, orderly condition.
- E. In event of spilling or splashing compound or finish material onto other surfaces, immediately remove spilled or splashed material and all trace of residue, to acceptance of Engineer.

### 3.06 WASTE MANAGEMENT

- A. Separate clean waste gypsum products from contaminants for recycling.
  - 1. Do not include wood, plastic, metal, asphalt-impregnated gypsum board, or any gypsum board coated with glass fiber, vinyl, decorative paper, paint, or other finish.
  - 2. Place in designated area and protect from moisture and contamination.
  - 3. Return to gypsum board manufacturer.

**END OF SECTION**

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## SECTION 09 30 00

### TILING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide
  - 1. Interior Tile:
    - a. Wall tile over backer board:
      - 1) Glazed wall tile.
    - b. Wall tile over concrete and/or concrete masonry units:
      - 1) Glazed wall tile.
  - 2. Tile accessories, including but not limited to:
    - a. Matching trim units.
  - 3. Setting materials and accessories.
- B. Related Sections:
  - 1. Section 04 20 00 - Unit Masonry Assemblies
  - 2. Section 06 10 53 - Miscellaneous Rough Carpentry
  - 3. Section 09 22 00 - Non-Structural Metal Framing
  - 4. Section 09 29 00 - Gypsum Board

##### 1.02 REFERENCES

- A. ADA A4.5 - Ground and Floor Surfaces
- B. ANSI:
  - 1. A108 - Installation of Tile
  - 2. A118 - Tile Materials
  - 3. A137.1 - Ceramic Tile
- C. TCA - Handbook for Ceramic Tile Installation

##### 1.03 DEFINITIONS

- A. Module Size: Actual tile size plus joint width.

##### 1.04 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.
- C. Samples:
  - 1. Initial Selection: Samples for initial selection purposes in form of manufacturer's color charts consisting of actual tiles or sections of tile showing full range of colors, textures, and patterns available for each type and composition of tile indicated. Include samples of grout and accessories involving color selection.

##### 1.05 QUALITY ASSURANCE

- A. Source Limitations:
  - 1. Tile: Provide from a single source, or the same production run, of consistent quality in appearance and physical properties for each contiguous area.

2. Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- B. Qualifications:
1. Manufacturer: 5 years' experience in the manufacture of tile.
  2. Contractor: 3 years' experience in the installation of tile.
- C. Codes and Standards:
1. Comply with pertinent codes and regulations.
  2. Comply with ANSI A137.1 for labeling tile packages.
  3. Comply with requirements of indoor air quality (IAQ) limits for indoor air pollutants.

## 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handling:
1. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units.
  2. If despite these precautions coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

## 1.07 PROJECT CONDITIONS

- A. Environmental Requirements:
1. Temperature: Maintain temperatures at 50 degrees F (10 degrees C) or more in tiled areas during installation and for 7 days after completion unless higher temperatures are required by referenced installation standard or manufacturer's instructions.
- B. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## 1.08 WARRANTY

- A. Manufacturer's Standard Warranty.

## 1.09 MAINTENANCE

- A. Extra Materials:
1. Provide for maintenance purposes, quantity equal to 3 percent of each type of material installed.
  2. Furnish from same production run as materials installed.
  3. Package and mark to identify building, material type, and color.
  4. Deliver and store where directed by Owner.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. Wall Tile:
1. Standard of Quality: Design is based on products of Dal-Tile Corporation.  
[www.daltileproducts.com](http://www.daltileproducts.com)
  2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. Ceramiche Ceasar by RBC Tile and Stone [www.rbctile.com](http://www.rbctile.com)
    - b. American Olean Tile Company, Inc. [www.americanolean.com](http://www.americanolean.com)
    - c. Ceramic Tile Works, Maple Grove, MN [www.ceramictileworksmn.com](http://www.ceramictileworksmn.com)
    - d. Crossville Tile [www.crossvilleinc.com](http://www.crossvilleinc.com)
    - e. Kate-lo Tile and Stone, Minneapolis, MN [www.katelotile.com](http://www.katelotile.com)
    - f. Lone Star Mosaics [www.lonestarmosaics.com](http://www.lonestarmosaics.com)

- g. United States Ceramic Tile Company [www.usctco.com](http://www.usctco.com)
- h. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 PRODUCTS

- A. General: Furnish tile complying with ANSI "Standard Grade" requirements unless otherwise indicated.
- B. Colors, Textures, and Patterns: Provide standard options for selection by Engineer.
- C. Factory Blending: For tile exhibiting color variations within ranges selected, blend tile in each package to show same range and colors.
- D. Mounting: Provide back or edge-mounted tile assemblies for factory mounting. Do not use for mounting tile in wet areas.

## 2.03 TILE PRODUCTS

- A. Glazed Wall Tile:
  - 1. Type: Interior type body, flat tile.
  - 2. Size: 4 inches by 12 inches.
  - 3. Thickness: 5/16-inch nominal thickness.
  - 4. Face: Plain face with standard edge.
  - 5. Finish: Opaque Glazed.
- B. Cementitious Tile Backer Board. See Section 09 29 00.
- C. Tile Accessories:
  - 1. Matching Base and Trim Units:
    - a. Base: Coved with surface bullnose top edge. Facial dimensions 6 inches by 6 inches.
    - b. Wainscot cap: Surface bullnose, facial dimensions 6 inches by 6 inches.
- D. Setting Materials:
  - 1. Portland cement mortar, ANSI A108.1.
  - 2. Dry set portland cement mortar, ANSI A118.1.
  - 3. Latex-portland cement mortar, ANSI A118.4, when mixed with latex admix.
  - 4. Mortar pigment: Alkali resistant, non-fading color pigment.
- E. Setting Accessories:
  - 1. Grout:
    - a. Sand-portland cement grout, ANSI A108.10.
    - b. Commercial portland cement grout, ANSI A118.6.
    - c. Dry-set grout, ANSI A118.6.
    - d. Latex-portland cement grout, ANSI A118.6.
  - 2. Elastomeric Sealants:
    - a. One-part mildew-resistant silicone sealant for non-traffic areas.
    - b. Colors to match grout.
  - 3. Silicone Grout Sealer:
    - a. TEC TA-257 Silicone Grout Sealer with non-gloss finish.
    - b. This sealer may enhance grout color after 48 hours.

## 2.04 MIXING MORTARS AND GROUT

- A. Mix to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions. Do not dilute latex additive.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

- D. Latex-Portland Cement Mortar:
  - 1. Provide either job mixed portland cement-sand mortar mixed with latex additive, or prepared dry set portland cement mortar mixed with latex additive or pre-packaged Portland cement dry mortar mix containing dry, redisturbable polymer additive to which only water may be added at Site.
  - 2. Job mixed mortar to be one-part portland cement to one-part fine sand.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing Work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- B. Verification of Conditions: Examine substrates, areas, and conditions where tile will be installed, with installer present. Verify that Work may commence in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies: Immediately notify Engineer. Do not proceed with installation in areas of discrepancy until fully resolved.

### **3.02 PREPARATION**

- A. Protection: Protect installed Work and materials of other trades.
- B. Field-Applied Surface Preparation: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.
- C. Fill racks, holes, and depressions with trowelable leveling and patching compound, according to tile-setting material manufacturer's written instructions.

### **3.03 INSTALLATION OF TILE**

- A. Comply with ANSI A108 Series "Specifications for Installation of Ceramic Tile."
- B. Wall Tile Over Acrylic-coated Glass Mat Gypsum Tile Backer Board: Install in accordance with TCA Method W245.
- C. Grout Joints:
  - 1. Coordinate floor and wall tile so that grout joints align.
  - 2. Provide soft joints at vertical inside corners and cove base tile to floor tile. Grout at these joints is prohibited.
- D. Control Joints:
  - 1. Wall: 12 feet on center maximum.

### **3.04 GROUTING**

- A. Preparation: Soak or dampen joints of tile to be grouted with portland cement grout. Soak or dampen other joints as recommended by grout manufacturer. If epoxy grout to be used, follow manufacturer's joint preparation instruction.
- B. Joints: Force grout into tile joints completely filling with compacted grout and covering mortar. Finish joints of square-edged tile flush with surface. Strike or tool joints of cushion-edged tile to depth of cushion. Fill gaps and skips, and retool.

- C. Curing: Damp cure portland cement mortar bed installations, latex-portland cement thin-set installations and grouts containing portland cement for minimum 72 hours.

### **3.05 SEALING**

- A. Seal all cement grout joints with silicone sealer after grout has cured 28 days.
  - 1. Use adequate ventilation.
  - 2. Cloth used with this product is combustible and should be discarded in closed, metal containers outside the building.
  - 3. Clean surface thoroughly. Dry and cure prior to application.
  - 4. Maintain surface temperature between 50 degrees to 80 degrees.
  - 5. Use full strength. Apply with paint brush, cloth, or grout seal applicator.
  - 6. Remove any excess sealer from tile surfaces immediately with a soft, dry cloth.

### **3.06 TOLERANCES**

- A. Joint Widths:
  - 1. Glazed Wall Tile: 1/16 inch.

### **3.07 REPAIR/RESTORATION**

- A. Touch up marred finishes, but replace units that cannot be restored to factory-finished appearance. Use materials and procedures recommended or furnished by manufacturer.

### **3.08 CLEANING**

- A. Site: Do not allow accumulation of scraps, debris arising from Work of this Section. Maintain premises in neat, orderly condition.
- B. System:
  - 1. Clean exposed surfaces of tile using materials and methods recommended by manufacturer.
  - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation.
  - 3. Protect metal surfaces and plumbing fixtures from effects of cleaning.
  - 4. Flush surfaces with clean water before and after cleaning.

### **3.09 DEMONSTRATION**

- A. Maintenance Instructions: Manufacturer's representative to schedule and attend meeting with Owner's representatives to explain:
  - 1. Maintenance and care instructions.
  - 2. Recommended maintenance program.
  - 3. Warranty requirements.

### **3.10 PROTECTION**

- A. Prohibit foot and wheeled traffic from using newly tiled floor for at least 3 days.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- C. Protect installed tile work with draft paper or other heavy covering during construction period to prevent staining, damage, and wear.

**END OF SECTION**



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## SECTION 09 97 21

### COATING SYSTEMS FOR WATER TREATMENT FACILITIES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide surface preparation and application of high-performance industrial coatings.
- B. Related Sections:
  - 1. Section 03 30 00 - Cast-in-Place Concrete
  - 2. Section 04 20 00 - Unit Masonry Assemblies
  - 3. Section 05 12 00 - Structural Steel Framing
  - 4. Section 05 50 00 - Metal Fabrications
  - 5. 08 11 13 Hollow Metal Doors and Frames (Commercial)

##### 1.02 REFERENCES

- A. ASTM - American Society for Testing Materials
- B. International Association of Corrosion Engineers (NACE)
- C. International Concrete Repair Institute (ICRI)
- D. NACE International (NACE)
- E. NSF - ANSI/NSF Standard 61 - Drinking Water System Components
- F. Society for Protective Coatings (SSPC):
  - 1. Volume 1: Good Painting Practice
  - 2. Volume 2: Systems and Specifications
  - 3. Supplement to Volume 2: Lead Paint Removal Guides 6I and 7I

##### 1.03 DEFINITIONS

- A. Applicator: Person applying the product in the field at Site.
- B. Containment: Equipment, supports, screens, tarps, or shrouds that prevent airborne debris generated during surface preparation and coating application from entering the environment, and also facilitates controlled collection of debris for disposal in compliance with current regional and federal regulations.
- C. Dry Film Thickness (DFT): Minimum dry coating thickness.
- D. Immersion Service: Surfaces subject to immersion, or constant exposure to high humidity and condensation.
- E. LEL: Lower Explosion Limit.
- F. Moderate Service: Surfaces subject to normal exposure and moderate humidity. Includes concrete, concrete masonry, structural steel, miscellaneous metals, doors, and frames.
- G. Regional: The state in which the Project is located and surrounding states.
- H. Severe Service: Surfaces subject to frequent splashing, spilling, and exposure to high humidity and condensation. Includes structural steel, miscellaneous metals, piping, valves, and equipment.

- I. SFPG: Square feet per gallon.
- J. VOC: Volatile Organic Compounds.

#### **1.04 SUBMITTALS**

- A. Manufacturers' current Product Data sheets.
  - 1. Coatings
  - 2. Abrasive(s)
  - 3. Additives (as applicable)
  - 4. Containment system
- B. Provide list of equipment to be used on this Project for review by Engineer.
- C. Material Safety Data Sheets (MSDS) for each product specified.
- D. Samples:
  - 1. Color chips of available colors.
  - 2. Recommended colors for color code marking.
- E. Written plan for containment of fugitive airborne particles compliant with current state and/or federal regulations.
- F. Post-construction Contract Closeout: Daily application records using Engineer's provided format, or Contractor's form pre-approved by Engineer.

#### **1.05 QUALITY ASSURANCE**

- A. Single Source Responsibility: Provide coating products from a single manufacturer.
- B. Qualifications:
  - 1. Applicator shall have minimum of 5 years application experience on projects of similar size and scope.
  - 2. Provide written statement from coating manufacturer's authorized representative attesting that Applicator has been instructed on proper preparation, mixing, and application procedures for coating specified.
  - 3. Provide regional references for coating contractor for a minimum of 5 different projects of similar size and scope completed in the last 5 years, including:
    - a. Contact person and phone number.
    - b. Project location.
    - c. Cost of coating work.
    - d. Start/finish dates.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to Site in original, factory-sealed containers bearing manufacturer's intact name and legible label with the following information.
  - 1. Material identification by name or number.
  - 2. Manufacturer's stock number, batch number, and date of manufacture.
  - 3. Color name and number.
- B. Storage:
  - 1. Store materials in an environmentally controlled location as recommended by coating manufacturer's product information guidelines.
  - 2. Store materials not in actual use in tightly covered containers.
  - 3. Comply with health and fire regulations of governing authorities having jurisdiction.

- C. Handling:
  - 1. Handle materials in a manner that precludes the possibility of contamination or incorrect product catalyzation.
  - 2. Do not open containers or mix components until surface preparation has been completed and approved by Engineer.
  - 3. Maintain containers used for storage, mixing, and application in a clean condition, free of foreign materials and residue.

## 1.07 PROJECT CONDITIONS

- A. Site Facilities:
  - 1. As necessary to maintain required ambient conditions and contract scheduling, the contractor shall provide all required equipment for supplemental heating, dehumidification and power.
  - 2. Maintain environmental conditions, including temperature, dew point and humidity within range recommended by coating manufacturer.
  - 3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being coated.
  - 4. Properly locate and vent all such heat sources to the exterior such that coating systems are unaffected by exhaust products.
  - 5. Provide lighting to the satisfaction of Engineer to illuminate the complete workspace during blasting, coating, and inspection operations.
- B. Environmental Conditions:
  - 1. Coating shall not be applied in rain, snow, fog, or mist.
  - 2. Conduct surface preparation and coating operations only when the following conditions are met.
    - a. Ambient air temperature is within limits recommended by coating manufacturer.
    - b. Steel surface temperature is more than 5 degrees above the dew point of the ambient air.
    - c. Surfaces to be painted are clean and completely dry.
  - 3. Immersion Service: Continuous forced ventilation in accordance with manufacturer's recommendation.
    - a. At a minimum provide 3 to 5 air exchanges per hour for 12 hours after application of the prime coat and for the first 24 hours following final finish coat application.
    - b. Maintain exhaust in compliance with state standards.
    - c. Provide containment during abrasive blasting operations to prevent emission of abrasives, existing coatings, and contaminants onto adjacent property, street, structures, or equipment.
  - 4. Provide the following through the use of dehumidification equipment:
    - a. Dew point of the ambient air at a minimum 15 degrees below the surface and air temperature.
    - b. Dehumidification shall be maintained at all times during surface preparation, coating application, and cure.
- C. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## 1.08 SEQUENCING AND SCHEDULING

- A. Schedule blasting, cleaning, and painting so that contaminants from cleaning process will not come in contact with wet, newly painted surfaces.
- B. Do not apply coatings until surface preparation has been approved by Engineer.
- C. Do not apply finish coats until:
  - 1. All prime coat application is completed.
  - 2. All surfaces have been cleaned.
  - 3. All surfaces have been approved for coating by Engineer.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Coatings:
  - 1. Acceptable Manufacture: Subject to compliance with specified requirements, acceptable manufacturers and products are:
    - a. BASF [www.basfbuildingsystems.com](http://www.basfbuildingsystems.com)
    - b. CIM Industries (CIM) [www.cimind.com](http://www.cimind.com)
    - c. General Polymers Corporation (GPC) [www.generalpolymers.com](http://www.generalpolymers.com)
    - d. L&M Construction (LMC) [www.lmcc.com](http://www.lmcc.com)
    - e. Sherwin Williams (SWC) [www.sherwin.com](http://www.sherwin.com)
    - f. Tnemec (TCI) [www.tnemec.com](http://www.tnemec.com)
- B. Sealant Caulking:
  - 1. Sika-Flex 1A by Sika Corporation [www.sikausa.com](http://www.sikausa.com)
- C. Corrosion Inhibitor: HoldTight 102 by HoldTight, Houston, TX [www.holdtight.com](http://www.holdtight.com)
- D. Lead Abatement Additive: Blastox by TDJ Group, Cary, IL [www.blastox.com](http://www.blastox.com)
- E. Substitutions: Manufacturer of comparable products submitted in compliance with Section 01 25 13.
- F. Substitution of fast-cure products or acceleration additives must receive prior approval by Engineer.

### **2.02 MATERIALS**

- A. Regulatory Requirements:
  - 1. Products shall comply with the United States Clean Air Act for maximum VOC content.
  - 2. Products shall comply with state environmental and health standards.
  - 3. All products shall be lead, chromate, mercury and heavy metals free.
- B. Thinners: Use thinners approved by coating manufacturer and within their recommended limits.
- C. Abrasives:
  - 1. Abrasive materials must be in compliance with state environmental and health standards.
  - 2. Properly size abrasives to provide the specified surface profile.
  - 3. Abrasive to include lead abatement additive.
  - 4. The use of abrasives exceeding 1 percent free silica is prohibited.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions for compliance with requirements for application and notify Engineer in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected.
- B. Notify Engineer in writing of anticipated problems using specified systems with substrates primed by others.
- C. Prepare existing materials or substrates to be coated to meet the requirements of specified coating system.
- D. Starting of painting Work will be construed as Contractor's acceptance of surfaces and conditions within any particular area.

### 3.02 PREPARATION

- A. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items not to be painted, or provide surface-applied protection prior to surface preparation and painting. Following completion of painting, reinstall removed items.
- B. Clean and remove all rust, slag, weld splatter, weld scabs, mill scale, loose paint, and surface contaminants.
- C. Chip or grind off flux, spatter, slag or other laminations left from welding. Grind welds and other sharp projects smooth.
- D. Re-blast all Surfaces:
  - 1. Where rusting has recurred.
  - 2. That do not meet the requirements of this Section.
- E. Feather edges of existing coating to form a smooth transition prior to spot priming.
- F. Scarify previously applied coatings in accordance with coating manufacturer's recommendations.
- G. All substrates: Prepare surface profiles in accordance with manufacturer's recommendations.
- H. Prime all bare metal and touch-up damaged shop-applied prime coat with specified primer. Prepare and coat in accordance with this Section.
- I. Abrasive to include lead abatement additive.
- J. Mix corrosion inhibitor and apply in accordance with manufacturer's recommendations.
- K. Concrete:
  - 1. Allow new concrete to cure 28 days.
  - 2. Verify dryness by testing in accordance with ASTM D4263.
    - a. Floors: If moisture is detected, perform Moisture Vapor Emission Testing in accordance with ASTM F1869.
    - b. Moisture content not to exceed 3 pounds per 1,000 square feet in a 24-hour period.
- L. Fill cracks and voids according to coating manufacturer's recommendations.
- M. Surface Preparation Classifications:
  - 1. P1: SSPC-SP1 - Solvent Cleaning.
    - a. Scarify surface by sanding.
    - b. Brush blast if recommended by coating manufacturer.
  - 2. P2: SSPC-SP2 - Hand Tool Cleaning.
  - 3. P3: SSPC-SP3 - Power Tool Cleaning
  - 4. P4:
    - a. Prepare concrete, concrete block, cement plaster, and drywall by removing all efflorescence, chalk, dust, dirt, grease, and other oils, and by roughening as required to remove glaze.
    - b. Scrap and grind fins and protrusions flush with surface.
    - c. Rake mortar joints clean.
    - d. Brush blast if recommended by coating manufacturer.
  - 5. P5: SSPC-SP5 - White Metal Blast Cleaning.
  - 6. P6: SSPC-SP6 - Commercial Blast Cleaning.
  - 7. P7: SSPC-SP7 - Brush Off Blast Cleaning.
  - 8. P9:
    - a. Clean wood surfaces to be painted of all dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required.
    - b. Sandpaper smooth those finished surfaces exposed to view.
  - 9. P10: SSPC-SP10 - Near White Blast Cleaning.
  - 10. P11: SSPC-SP11 - Power Tool Cleaning to Bare Metal.

11. P12: SSPC-SP12 - LP-WC/WJ-4: Pressure Wash
12. P13: SSPC-SP13 - Surface Preparation of Concrete:
  - a. 4.3.1.: Abrasive Blast.
  - b. 4.3.2.: High Pressure Water Cleaning.
13. P14: SSPC-SP16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
14. P15: NAPF 500-03-04 Abrasive Blast Cleaning.

- N. Re-blast all Surfaces:
1. Where rusting has recurred.
  2. That do not meet the above requirements.

### 3.03 MATERIALS PREPARATION

- A. Mix and prepare materials in accordance with manufacturer's directions.
- B. Maintain containers used in mixing and application in a clean condition, free of foreign materials and residue.
- C. The following is prohibited:
  1. Field mixing of partial containers.
  2. Field mixing of lead abatement additive.
  3. Field tinting.

### 3.04 APPLICATION

- A. Surface preparation and coating system are as indicated in the "Coating Schedule" at the end of this Section, or noted on Drawings.
- B. Use equipment and techniques best suited for substrate and type of material being applied.
- C. Apply in accordance with manufacturer's directions.
  1. Do not apply in snow, rain, fog, mist, or damp surfaces.
  2. Allow wet surfaces to dry thoroughly and attain the temperature and conditions specified before proceeding with or continuing the painting operation.
  3. Work may continue during inclement weather only if areas and surfaces are enclosed and temperatures within the area can be maintained within limits specified during application and drying periods.
- D. Avoid degradation and contamination of surfaces and avoid intercoat contamination.
  1. Surfaces shall be free from grease, oil, abrasives, and other contaminants that may have an adverse affect on coating application, bonding, curing, or performance.
  2. Clean contaminated surfaces before applying next coat.
  3. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable system.
- E. Brush-apply primer or intermediate on all welds and edges prior to general application of finish coat.
- F. Apply caulking to flange interfaces, gaps, and intermittent weld seams.
- G. Provide finish coats that are compatible with primers used. Prime and intermediate coats shall be lighter than subsequent coat.
- H. Provide application thickness to specific mil requirements. Mil thicknesses referenced are in dry mil thickness.
- I. All paint systems are "full coverage." Where discrepancies between manufacturer's square foot coverage and mil thickness occur, use mil thickness requirements.

- J. Where voids are present exposing the substrate or undercoats, apply additional coats until a uniform color and finish is obtained. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
- K. Do not apply additional coats until Engineer has had the opportunity to inspect and approve previous coat.
- L. Unless otherwise indicated, match color of adjacent walls or equipment when painting conduit, miscellaneous brackets, hangers, and supports.
- M. Smooth out runs or sags immediately, or remove and recoat entire surface.
- N. Allow preceding coats to dry before recoating. Recoat within time limits specified by coating manufacturer.
- O. Do not apply coatings to the following surfaces:
  - 1. Factory or installer-finished items.
  - 2. Anodized aluminum, stainless steel, or other pre-finished metal.
  - 3. Moving parts of operating devices.
  - 4. Sprinkler heads or other fire detection/suppression elements.
  - 5. Code required labels or equipment nameplates.

### 3.05 COLOR CODING

- A. Pipes Exposed or Concealed in Accessible Pipe Spaces:
  - 1. Provide with color band and arrow indicating direction of flow, and legend adjacent to valves, at not more than 20-foot spacing on straight pipe runs, adjacent to change in direction, and on both sides where pipes pass through walls or floors.
  - 2. Color-coding shall be based on pipe contents in accordance with the "Pipe Color Schedule" at the end of this Section, or noted on Drawings.
- B. Bands: Color and of width indicated.
- C. Arrows: Install adjacent to each band and legend to indicate direction of flow in pipe.
- D. Legends:
  - 1. Print in uppercase letters and letter sizes as listed in this Section to match "arrow".

### 3.06 QUALITY CONTROL

- A. Contractor shall provide all necessary equipment to monitor and record the information required on the Daily Application Record.
  - 1. Equipment shall be in good condition.
  - 2. Operational within its design range.
  - 3. Calibrated as required by the specified standard for use of each device.
- B. Maintain a copy of the following information at the site:
  - 1. Product Data Sheets.
  - 2. Material Safety Data Sheets (MSDS).
  - 3. Contract Document and submittals.
  - 4. Daily Application Record.
    - a. Record information (in English) on form located at the end of this Section.
- C. Owner's representative may be on site to observe the application of each coating, and the preparation of each substrate.
- D. Provide safe and complete access to all surfaces for observation by Owner and/or Engineer.
- E. Prepare rigging so that all surfaces are within arm's reach of observer.



- F. Measure wet paint with wet film thickness gages.
- G. Provide DFT measurements for all coatings in accordance with SSPC-PA2.
- H. Perform Holiday testing in accordance with NACE RPO 188 as directed by Engineer.
- I. Correct any deficiencies observed or detected by field testing as directed by Engineer.

### **3.07 CLEANING AND PROTECTION**

- A. During progress of Work, remove discarded materials, rubbish, cans, and rags at end of each workday from the Site.
- B. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.
- C. Upon completion of Work:
  - 1. Clean window glass and spattered surfaces.
  - 2. Remove spattered paint by washing and scraping, using care not to scratch or otherwise damage finished surfaces.
- D. Protect Work of other trades against damage. Correct any damage by cleaning, repairing or replacing, and repainting.
- E. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided for protection of Work, after completion of painting operations.
- F. At completion of Work of other trades, touch-up and restore damaged or defaced surfaces.

### **3.08 SCHEDULES**

- A. See the following pages.

### Coating Systems

SYSTEM NUMBER	TYPE	SUBSTRATE/ SERVICE	SURFACE PREP	MFG	FIRST COAT	DFT (Mils)	SECOND COAT	DFT (Mils )	FINISH COAT	DFT (Mils)	NOTES
C1	Epoxy	Concrete Immersion (potable)	P13 4.3.1	SWC	Macropoxy 646 PW	5.0-10.0	Macropoxy 646 PW	5.0-10.0			Fill bugholes and voids with Steel Seam FT910 or Duraplate 2300
				TCI	Series N140	4.0-6.0	Series N140	4.0-6.0			Can substitute Series 20 in lieu of Series N140 Fill bugholes and voids with Series 215 or Series 218
C2	Epoxy (Low Temp)	Concrete Immersion (potable)	P13 4.3.1	SWC	Duraplate 235 NSF	5.0-7.0	Duraplate 235 NSF	5.0-7.0			Fill bugholes and voids with Steel Seam FT910.Or Duraplate 2300
				TCI	Series N140F	4.0-6.0	Series N140F	4.0-6.0			Can substitute Series FC20 in lieu of Series N140F Fill bugholes and voids with Series 215 or Series 218
C3	100% Solids Amine Cured Epoxy	Concrete Immersion (potable)	P13 4.3.1	SWC	Duraplate UHS Primer	6.0-8.0	Duraplate UHS	20.0-28.0			Fill bugholes and voids with Steel Seam FT 910 or Duraplate 2300
				TCI	Series N140	4.0-6.0	Series 22	20.0-40.0			Can substitute Series 20 in lieu of Series N140 Fill bugholes and voids with Series 215 or Series 218
C4	Urethane (Flexible)	Concrete Immersion (potable)	P13 4.3.1	SWC	Duraplate 235 NSF	6.0-8.0	Sherflex	80.0-100.0			Fill bugholes and voids with Steel Seam FT 910.or Duraplate 300
				TCI	Series N140	4.0-6.0	Series 406	25.0-75.0			Fill bugholes and voids with Series 215 or Series 218
				SWC	Duraplate 235 NSF	5.0-7.0	Sherplate PW	20.0-50.0			Fill bugholes and voids with Steel Seam FT 910 or Duraplate 2300
				TCI	Series N140	4.0-6.0	Series 22	20.0-40.0			Can substitute Series 20 in lieu of Series N140 Fill bugholes and voids with Series 215 or Series 218
C6	100% Solids Moisture Tolerant Epoxy	Concrete Immersion and Severe service	P13 4.3.1	SWC	Corobond 100	4.0-6.0	Duraplate 5900 mortar	125.0- 250.0			Fill bugholes and voids with Steel Seam FT 910 or Duraplate 2300
C7	Acrylic Blockfiller/ Cementitious Acrylic	Concrete & Masonry Exterior	P4	SWC	Porous Substrates- Heavy Duty Block Filler	60-80 SFPG	Ultra-Crete	4.0-8.0	Ultra-Crete	4.0-8.0	No Block Filler on Smooth Concrete
				TCI	Porous substrates- Series 130	60-115 SFPG	Series 181	4.0-10.0	Series 181	4.0-10.0	No Block Filler on Smooth Concrete

### Coating Systems

SYSTEM NUMBER	TYPE	SUBSTRATE/ SERVICE	SURFACE PREP	MFG	FIRST COAT	DFT (Mils)	SECOND COAT	DFT (Mils)	FINISH COAT	DFT (Mils)	NOTES
C8	Cementitious Acrylic/WB Epoxy	Concrete & Masonry Interior	P4	SWC	Cementplex 875	80-100 SFPG	Pro Industrial WB Catalyzed Epoxy	2.0-4.0	Pro Industrial WB Catalyzed Epoxy	2.0-4.0	No Block Filler on Smooth Concrete
				TCI	Porous substrates- Series 130	60-115 SFPG	Series 113/114	4.0-6.0	Series 113/114	4.0-6.0	No Block Filler on Smooth Concrete
C9	Epoxy	Concrete & Masonry Interior	P4	SWC	Porous Substrates- Heavy Duty Blockfiller	60-80 SFPG	Macropoxy 646	3.0-6.0	Macropoxy 646	3.0-6.0	No Block Filler on Smooth Concrete
				TCI	Porous substrates - Series 130	60-115 SFPG	Series N69	4.0-6.0	Series N69	4.0-6.0	No Block Filler on Smooth Concrete
C10	Elastomeric Acrylic	Concrete & Masonry Exterior	P4	SWC	Loxon XP	90-115 SFPG	Loxon XP	90-115 sq/ft gal.			
				TCI	Series 156	4.0-8.0	Series 156	4.0-8.0			Fill porous block with Series 130
C11	Coal Tar	Concrete Exterior Below Grade Soil Side	P13 4.3.1	SWC	High Mil Shertar	14.0-20.0					
				TCI	Series 46H-413	14.0-20.0					
C12	Silane/Siloxane Blend	Concrete & Masonry Exterior Water Repellent	P4	SWC	Loxon 40% Silane	75-125 SFPG					
				TCI	Series 662	75-150 SFPG					
D1	Epoxy/Acrylic Urethane	Ductile Iron Outside Diameter Exterior Exposed	P15	SWC	Macropoxy 646	3.0-6.0	Macropoxy 646	3.0-6.0	Acrolon Ultra	2.0-3.0	
				TCI	Series N140	3.0-5.0	Series N140	4.0-6.0	Series 1095	2.0-3.0	Note: Can substitute N140 with Series 49 for low-VOC, high solids
D2	Epoxy	Ductile Iron Outside Diameter Interior Exposed	P15	SWC	Macropoxy 646	3.0-6.0	Macropoxy 646	3.0-6.0			
				TCI	Series N69	3.0-5.0	Series N69	4.0-6.0			Note: Can substitute N69 with Series 49 for low-VOC, high solids
D3	Coal Tar Epoxy	Ductile Iron Outside Diameter Exterior Buried	P15	SWC	High Mil Shertar	14.0-20.0					
				TCI	Series 46H-413	14.0-20.0					
D4	Amine Cured Epoxy	Ductile Iron Inside & Outside Diameter Immersion (Potable)	P15	SWC	Duraplate UHS	10.0-12.0	Duraplate UHS	10.0 -12.0			OAP Recommended
				TCI	Series N140	3.0-5.0	Series 22	20.0-40.0			Can substitute Series 20 in lieu of Series N140

### Coating Systems

SYSTEM NUMBER	TYPE	SUBSTRATE/ SERVICE	SURFACE PREP	MFG	FIRST COAT	DFT (Mils)	SECOND COAT	DFT (Mils )	FINISH COAT	DFT (Mils)	NOTES
D5	Personal Protective Coating	Ductile Iron Outside Diameter Interior Exposed	P15	SWC	Heat Flex 1200	5.0-6.0	Heat Flex 3500	40-100*	Shercryn HPA	2.0-4.0	*Temperature Dependent Consult Sherwin Williams Rep for Specific Recommendation
				TCI	Series 1224	6.0-8.0	Series 971	30.0-50.0	Series 1028T	2.0-3.0	*For personnel protection with operating temperatures up to 325 degrees F
S1	Epoxy	Steel Immersion (potable)	P10	SWC	Macropoxy 646 PW	5.0-10.0	Macropoxy 646 PW	5.0-10.0			
				TCI	Series N140	3.0-5.0	Series N140	4.0-6.0			Can substitute Series 20 in lieu of Series N140
S2	Epoxy (Low Temp)	Steel Immersion (potable)	P10	SWC	Duraplate 235 NSF	5.0-7.0	Duraplate 235 NSF	5.0-7.0			
				TCI	Series N140F	3.0-5.0	Series N140F	4.0-6.0			Can substitute Series FC20 in lieu of Series N140F
S3	Amine Cured Epoxy	Steel Immersion (potable)	P10	SWC	Duraplate UHS Primer*	6.0-8.0	Duraplate UHS	18.0-22.0			*OAP Recommended
				TCI	Series 91-H <sub>2</sub> O	2.5-3.5	Series 22	20.0-40.0			Stripe coat seams with Series N140 or Series 20
S4	High Build Amine Cured Edge Retentive Epoxy	Steel Immersion (potable)	P10	SWC	Duraplate UHS primer	6.0-8.0	Sherplate PW	20.0- 22.0			*OAP Recommended Primer is optional
				TCI	Series 91-H <sub>2</sub> O	2.5-3.5	Series 22	20.0-40.0			Stripe coat seams with Series N140 or Series 20
S5	Elastomeric Urethane	Steel Immersion (potable)	P10	SWC	Duraplate 235 NSF	3.0-6.0	Sherflex S	30.0-40.0			Primer is optional
				TCI	Series 91-H <sub>2</sub> O	2.5-3.5	Series 406	25.0-75.0			Stripe coat seams with Series N140 or Series 20
S6	Epoxy	Steel Interior Exposed	P6	SWC	Macropoxy 646	3.0-6.0			Macropoxy 646	3.0-6.0	
				TCI	Series N69	3.0-5.0			Series N69	3.0-5.0	Note: Can substitute N69 with Series 49 for low-VOC, high solids
S7	Epoxy/ Acrylic Urethane	Steel Exterior Exposed	P6	SWC	Macropoxy 646	3.0-6.0	Macropoxy 646	3.0-6.0	Acrolon Ultra	2.0-3.0	
				TCI	Series N140	3.0-5.0	Series N140	3.0-5.0	Series 1095	2.0-3.0	Note: Can substitute N140 with Series 49 for low-VOC, high solids
S8	Polyurethane	Doors and Frames	P1	SWC	See Note		See Note		Acrolon Ultra	2.0-3.0	First Coat: Compatible tie coat as recommended by coating manufacturer
				TCI			*Series 48	2.0-3.0	Series 1095	2.0-3.0	Confirm compatibility with factory-primed surfaces prior to coating

### Coating Systems

SYSTEM NUMBER	TYPE	SUBSTRATE/ SERVICE	SURFACE PREP	MFG	FIRST COAT	DFT (Mils)	SECOND COAT	DFT (Mils)	FINISH COAT	DFT (Mils)	NOTES
S9	Acrylic	Steel Interior and Exterior Moderate	P6	SWC	Sher-Cryl HPA	2.5-4.0	Sher-Cryl HPA	2.5-4.0			Factory primed metal deck and joists: Prepare surfaces according to manufacturer recommendation
				TCI	Series 1028	2.0-3.0	Series 1028	2.0-3.0			Factory primed metal deck and joists: Prepare surfaces according to manufacturer recommendation
S10	Epoxy/ Polyester Polyurethane	Steel Exterior	P6	SWC	Macropoxy 646	3.0-6.0	Macropoxy 646	3.0-6.0	Polylon HP	2.0-3.0	
				TCI	Series N140	3.0-5.0	Series N140	2.0-3.0	Series 290	2.0-3.0	Can substitute Series N140 with 49 for low-VOC. High-solids
S11	Personal Protective Coating	Steel Interior and Exterior Safe Touch	P10	SWC	Heat Flex 1200	5.0-6.0	Heat Flex 3500	40-100*	Shercryl HPA	2.0-4.0	*Temperature Dependent Consult Sherwin Williams Rep for Specific Recommendation
				TCI	Series 1224	6.0-8.0	Series 971	30.0-50.0	Series 1028T	2.0-3.0	*For personnel protection with operating temperatures up to 325 degrees F
NF1	Epoxy	Galvanized and Non Ferrous Metals Interior Exposed	P14	SWC	Macropoxy 646	3.0-6.0	Macropoxy 646	3.0-6.0			
				TCI	Series N69	2.0-3.0	Series N69	2.0-3.0			
NF2	Epoxy/ Acrylic Urethane	Galvanized and Non Ferrous Metals Exterior Exposed	P14	SWC	Macropoxy 646	3.0-6.0	Acrolon Ultra	2.0-3.0			
				TCI	Series N140	2.0-3.0	Series 1095	2.0-3.0			
PVC1	Epoxy/Acrylic Urethane	PVC Exterior Exposed	P1a	SWC	Macropoxy 646	3.0-6.0	Acrolon Ultra	2.0-3.0			
				TCI	Series N140	2.0-3.0	Series 1095	2.0-3.0			
PVC1	Epoxy	PVC Interior Exposed	P1a	SWC	Macropoxy 646	3.0-6.0	Macropoxy 646	3.0-6.0			
				TCI	Series N69	2.0-3.0	Series N69	2.0-3.0			
PVC2	Acrylic	PVC	P1a	SWC	Shercryl HPA	2.0-4.0	Shercryl HPA	2.0-4.0			
				TCI	Series 1029	2.0-3.0	Series 1029	2.0-3.0			
IP1	Acrylic	Insulated Pipe	P1	SWC	Shercryl HPA	2.0-4.0	Shercryl HPA	2.0-4.0			
				TCI	Series 1029	2.0-3.0	Series 1029	2.0-3.0			

### Coating Systems

SYSTEM NUMBER	TYPE	SUBSTRATE/ SERVICE	SURFACE PREP	MFG	FIRST COAT	DFT (Mils)	SECOND COAT	DFT (Mils )	FINISH COAT	DFT (Mils)	NOTES
WPG1	Acrylic	Wood Plaster Gypsum	P9	SWC	Pro Ind Acrylic	2.5-4.0	Pro Ind Acrylic	2.5-4.0			
				TCI	Series 151	1.0-2.0	Series 1029	2.0-3.0			
WPG2	Latex/Vinyl Acrylic	Architectural Gypsum Board	P1	SWC	Promar 200 primer	1.0-1.5	Promar 200	1.5-2.0	Promar 200	1.5-2.0	
				TCI	Series 51	1.0-2.0	Series 1029	2.0-3.0	Series 1029	2.0-3.0	
F1	Silicate Blend	Concrete Floor Mild Exposure	P4	SWC	Sher-crete Lithium Silicate Concrete Hardner	300-350 SFPG	Sher-crete Lithium Silicate Concrete Hardner	350-400 Sq/ft gal			
				TCI		Discontin- ued					
F2	1/8-inch Thick Aggregate- Filled Pigmented Epoxy	Concrete Floor Pigmented Heavy Traffic Chemical Resistant	P13 4.3.1	SWC	GP 3579	4.0-6.0	GP 3561	Double Broadcast 1/8-inch	GP3744	6.0-8.0	
				TCI	Series 201	4.0-6.0	Series 237	Double Broadcast 1/8-inch	Series 280	6.0-12.0	
F3	1/8-inch Thick Decorative Quartz-Filled Epoxy	Concrete Floor Decorative Quartz Heavy Traffic	P13 4.3.1	SWC	GP 3579	4.0-6.0	GP 3561	Double Broadcast 1/8-inch	GP 3744 GP 4638	6.0-8.0 2.0-3.0	4 coat system
				TCI	Series 201	4.0-6.0	Series 222	Double Broadcast 1/8-inch	Series 284 Series 295	14.0-16.0 2.0-3.0	
F4	High Build Decorative Flake-Filled Epoxy	Concrete Floors Decorative Flake Heavy Traffic	P13 4.3.1	SWC	GP 3579	4.0-6.0	GP 3589	8.0-10.0 Broadcast Flake	GP 3744 GP 4638	8.0-10.0 8.0-10.0	4 coat system
				TCI	Series 281	6.0-8.0	Series 224	8.0-10.0 Broadcast with Flake	Series 284 Series 295	8.0-12.0 2.0-3.0	

### Coating Systems

SYSTEM NUMBER	TYPE	SUBSTRATE/ SERVICE	SURFACE PREP	MFG	FIRST COAT	DFT (Mils)	SECOND COAT	DFT (Mils )	FINISH COAT	DFT (Mils)	NOTES
F5	Epoxy	Concrete Floors Pigmented Epoxy Light Traffic Low Impact	P13 4.3.1	SWC	Macropoxy 646	5.0-10.0	Macropoxy 646	5.0-10.0	GP 4638 Urethane	2.0-3.0	Urethane is Optional
				TCI	Series N140	5.0-10.0	Series N140	5.0-10.0	Series 290	2.0-3.0	Substitute Series N69 with Series 49 for low-VOC, high- solids

**NOTES:**

Any Secondary Chemical Containment and Immersion Grade Chemical Resistant commodities will be specified on case by case basis by the Protective Coatings Management Group in conjunction with Manufacturer's Chemical Resistant Guides.

Prepared concrete surfaces must be filled if the surface is too rough. Fairing the surface to fill bugholes and voids to near smooth is mandatory prior to coating application. Some surface texture after filling may be approved and recommended for adhesion of subsequent coats.

Optically Activated Pigment (OAP) which may be used for supplementary visual holiday detection. OAP is not a replacement for NACE standard SPO-188-2006.

Galvanized metal is not recommended for wastewater immersion due to adverse chemical reaction(s).





**Water Treatment Plants and Pumping Stations  
Piping Color Code**

<b>USAGE</b>	<b>COMMODITY</b>	<b>COLOR STANDARD</b>	<b>SHERWIN WILLIAMS COLOR #</b>	<b>TNEMEC COLOR #</b>
Water Lines	Raw	Olive Green	4024	112GN
	Settled or Clarified	Aqua	4061	10GN
	Finished or Potable	Dark Blue	4064	27BL
Chemical Lines	Alum or Primary Coagulant	Orange	4083	04SF
	Ammonia	White	Ultra White	11WH
	Carbon Slurry	Black	Black	35GR
	Caustic	Yellow with Green Band	4084/4071	02SF/08SF
	Chlorine	Yellow	4084	02SF
	Chlorine Dioxide	Yellow with Violet Band	4084/4080	02SF/14SF
	Fluoride	Light Blue with Red Band	4061/4081	37BL/06SF
	Lime Slurry	Light Green	4069	52GN
	Ozone	Yellow with Orange Band	4084/4083	02SF/04SF
	Phosphate Compounds	Light Green with Red Band	4069/4081	52GN/06SF
	Polymers or Coagulant Aids	Orange with Green Band	4083/4071	04SF/08SF
	Potassium Permanganate	Violet	4080	14SF
	Soda Ash	Light Green with Orange Band	4069/4083	52GN/04SF
	Sulfuric Acid	Yellow with Red Band	4084/4081	02SF/06SF
	Sulfur Dioxide	Light Green with Yellow Band	4069/4084	52GN/02SF
Waste Lines	Backwash Waste	Light Brown	4001	40BR
	Sludge	Dark Brown	4009	84BR
	Sewer	Dark Gray	4025	55BL
Other	Compressed Air	Dark Green	4071	08SF
	Gas	Red	4081	06SF
	Other Lines	Light Gray	4026	32GR

**WASTEWATER TREATMENT PLANTS  
Piping Color Code**

<b>PIPE CONTENT</b>	<b>COLOR STANDARD</b>	<b>SHERWIN WILLIAMS COLOR #</b>	<b>TNEMEC COLOR #</b>
Raw Sludge Line	Brown with Black Band	4009/Black	85BR/35GR
Sludge Recirculation Suction Line	Brown with Yellow Band	4009/4084	85BR/02SF
Sludge Draw-Off Line	Brown with Orange Band	4009/4083	85BR/04SF
Sludge Recirculation Discharge Line	Brown	4009	85BR
Sludge Gas Line	Orange (Or Red)	4083	04SF
Natural Gas Line	Orange (Or Red) with Black Band	4083/Black	04SF/35GR
Non Potable Water Line	Blue with Black Band	4064/Black	27BL/35GR
Potable Water Line	Blue	4064	27BL
Chlorine Line	Yellow	4084	02SF
Sulfur Dioxide	Yellow with Red Band	4084/4081	02SF/06SF
Sewage (Wastewater) Line	Gray	4025	55BL
Compressed Air	Green	4071	08SF
Water Lines For Heating Digesters Or Buildings	Blue with Red Band (6nin. wide By 30-Inch Spacing)	4064/4081	27BL/06SF

**END OF SECTION**

## DAILY APPLICATION RECORD

DATE			RECORD EVERY 3 HOURS					Weather Conditions
			Surface Temperature (Deg. F.)	Air Temperature (Deg. F.)	Material Temperature (Deg. F.)	Relative Humidity (%)	Dew Point (Deg. F.)	
TIME START	AM	PM						
	AM	PM						
	AM	PM						
	AM	PM						
	AM	PM						
TIME STOP	AM	PM						

Area Prepared	
Area Coated	
Type of Material & Quantity Applied:	

**SIGNED**

<b>PROJECT NAME:</b>	<b>SEH FILE #:</b>
<b>OWNER:</b>	<b>CONTRACTOR:</b>

## SECTION 10 28 13

### TOILET ACCESSORIES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Grab bars.
  - 2. Toilet paper dispenser.
  - 3. Channel frame mirror.
  - 4. Paper towel dispenser
- B. Related Sections:
  - 1. Section 04 20 00 - Unit Masonry Assemblies

##### 1.02 REFERENCES

- A. ASTM:
  - 1. A666 - Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, Flat Bar
  - 2. C1503 - Silvered Flat Glass Mirror
  - 3. F446 - Grab Bars and Accessories for Bathing Areas

##### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Product Data:
  - 1. Manufacturer's current Product Data.
  - 2. Handling, storage requirements.
  - 3. Installation instructions, including construction details and dimensions, anchoring and mounting details.
  - 4. Requirements for cutouts and substrate preparation.
  - 5. Maintenance recommendations.

##### 1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide toilet accessory units made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
- B. Qualifications:
  - 1. Manufacturer: 5 years' experience in the manufacture of toilet accessories.
  - 2. Contractor: 3 years' experience in the installation of toilet accessories.
  - 3. Personnel: For actual installation of toilet accessories, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of Work.
- C. Field Samples: If requested, furnish sample of each type of toilet accessories to Architect for review prior to manufacture/installation. Architect will forward approved sample to the Site for installation.

##### 1.05 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

## 1.06 PROJECT CONDITIONS

- A. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## 1.07 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form, agreeing to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within 15 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. General Toilet Accessories:
  - 1. Standard of Quality: Unless otherwise indicated, design is based on products of Bradley Corp., Menomonee Falls, WI [www.bradleycorp.com](http://www.bradleycorp.com)
  - 2. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
    - a. All American Metal Corporation
    - b. American Specialties, Inc., Yonkers, NY [www.americanspecialties.com](http://www.americanspecialties.com)
    - c. Bobrick Washroom Equipment Inc., Clifton Park, NY [www.bobrick.com](http://www.bobrick.com)
    - d. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

### 2.02 MATERIALS

- A. ASTM A666, 304 stainless steel with satin finish, unless otherwise specified below.
- B. Mirrors:
  - 1. ASTM C1503 - Mirror Glazing Quality.
  - 2. Clear glass.
  - 3. Nominal 6.0 mm thick.

### 2.03 PRODUCTS

- A. Grab Bars:
  - 1. 1-1/2-inch diameter; 18-gage tubing; safety grip finish; vandal resistant concealed mounting: 812 Series.
  - 2. Grab bars shall be capable of supporting minimum dead load of 250 pounds.
- B. Toilet Paper Dispenser:
  - 1. Dual Roll: Non-controlled delivery; Model 5234.
- C. Waste Receptor: 22 gage with seamless exposed surfaces; Removable 18 gallon receptacle with heavy duty vinyl liner:
  - 1. Surface Mounted: Model 334-11
- D. Channel Framed Mirror: One-piece roll-formed stainless steel channel frame with tempered glass. 15-year warranty against silver spoilage.
  - 1. Without Shelf: Model 781.
- E. Towel Dispenser:
  - 1. Kimberly-Clark Professional Sanitouch Hard Roll Towel Dispenser
    - a. Color: Smoke

- F. Other Materials: Other materials not specifically described but required for complete, proper installation of toilet accessories, subject to acceptance of Architect.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- B. Verification of Conditions: Verify that toilet accessories may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies: Immediately notify Architect. Do not proceed with installation in areas of discrepancy until fully resolved. Commencement of installation signifies acceptance of surface conditions.

### **3.02 PREPARATION**

- A. Protection: Protect installed work and materials of other trades.

### **3.03 INSTALLATION**

- A. General Requirements:
  - 1. Install plumb, true, square in neat, rigid, substantial manner.
  - 2. Use theft-proof screws to install toilet accessories.
  - 3. Fasten to masonry with screws and expansion shields.
  - 4. Anchor grab bars securely. Install to withstand downward load of minimum 250 pounds per ASTM F446.
  - 5. After erection, clean surfaces, adjust hardware, and leave in good operating condition.

### **3.04 ADJUSTING AND CLEANING**

- A. Site: Do not allow accumulation of scraps, debris arising from Work of this Section. Maintain premises in neat, orderly condition.
- B. Toilet Accessories:
  - 1. Adjust for unencumbered smooth operation.
  - 2. Remove protection film.
  - 3. Accessories to be free of dust, grime, streaks.
  - 4. Clean and polish exposed surfaces
  - 5. Inspect installation to verify secure and proper mounting. Test each hand dryer to verify operation, control functions, and performance. Correct deficiencies.

**END OF SECTION**

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**SECTION 10 44 00**  
**SAFETY SPECIALTIES**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Provide:
  - 1. Fire extinguishers:
    - a. Dry chemical extinguisher.
    - b. Wall bracket.
- B. Related Sections:
  - 1. Section 04 20 00 - Unit Masonry Assemblies
  - 2. Section 09 29 00 - Gypsum Board

**1.02 SUBMITTALS**

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, rating and classification, dimensions of individual components and profiles, finishes, handling, storage and installation instructions, and maintenance recommendations.

**1.03 QUALITY ASSURANCE**

- A. Single Source Responsibility: Provide life protection specialties units made of components of standard construction furnished by 1 manufacturer as coordinated assemblies.
- B. Qualifications:
  - 1. Manufacturer: 5 years' experience in the manufacture of life protection specialties.
  - 2. For actual installation of life protection specialties, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.
- C. Regulatory Requirements:
  - 1. UL Listing: Provide portable fire extinguishers which are UL listed and bear UL "Listing Mark" for type, rating and classification of extinguisher listed.
  - 2. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10 "Portable Fire Extinguishers."
- D. Preinstallation Conference: Conduct at Site with Engineer, Representative of Authority Having Jurisdiction from Fire Dept., and Owner to review methods and procedures related to fire extinguishers and life safety equipment, including schedules and coordination requirements. Revise locations if directed by AHJ Representative.

**1.04 WARRANTY**

- A. Provide manufacturer's 6-year warranty to repair or replace fire extinguishers and life safety equipment that fail in materials or workmanship.
- B. Fire extinguisher failures include, but are not limited to, failure of hydrostatic test according to NFPA 10 and faulty operation of valves or release levers.



## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Standard of Quality: Design is based on products of J.L. Industries, Bloomington, MN [www.jlindustries.com](http://www.jlindustries.com)
- B. Other Acceptable Manufacturers: Subject to compliance with requirements, acceptable manufacturers and products are:
  - 1. Amerex Corporation, Trussville, AL [www.amerex-fire.com](http://www.amerex-fire.com)
  - 2. Larsens Manufacturing Company, Minneapolis, MN [www.larsensmfg.com](http://www.larsensmfg.com)
  - 3. Nystrom, Brooklyn Park, MN [www.Nystrom.com](http://www.Nystrom.com)
  - 4. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

### **2.02 COMPONENTS**

- A. Fire Extinguishers:
  - 1. Fully charged and ready for use at final acceptance.
  - 2. Enameled-steel container with pressure-indicating gage.
  - 3. Size, type indicated in schedule at end of this section.
  - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.
- B. Standard Wall Hanger Brackets:
  - 1. Size in accordance with fixture size where indicated by symbol on Drawings or as directed by Engineer.
  - 2. Locate as indicated by Drawings **AND** schedule.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- B. Verification of Conditions: Verify specialties may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Examine fire extinguishers and life safety equipment for proper charging and tagging. Remove and replace damaged, defective, or undercharged fire extinguishers.
- D. Discrepancies: Immediately notify Engineer. Do not proceed with installation in areas of discrepancy until fully resolved. Commencement of installation signifies acceptance of surface conditions.

### **3.02 INSTALLATION**

- A. Install in accordance with ADA code.
- B. Install plumb, true, square in neat, rigid, substantial manner.
- C. Install in compliance with requirements of authorities having jurisdiction.
- D. Clean surfaces, adjust hardware, leave in good operating condition.

### 3.03 SCHEDULE

A. Schedule:

<b>Drawing Symbol</b>	<b>Size and Type</b>	<b>Rating</b>	<b>General Location</b>
FE	10-pound ABC Dry Chemical (bracket)	4A:60B:C UL	As indicated on Code Plans for each building.

**END OF SECTION**

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## SECTION 12 30 00

### MANUFACTURED CASEWORK

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Metal casework.
  - 2. Casework accessories including, but not limited to:
    - a. Hardware.
    - b. Prefinished steel support brackets.
    - c. Filler panels.
    - d. Casework joint sealant.
  - 3. Countertop:
    - a. Epoxy resin.
  - 4. Sink:
    - a. Undermount Epoxy resin.
  - 5. Countertop accessories including, but not limited to:
    - a. Casework joint sealant.
  - 6. Epoxy drying rack.
- B. The following is not included in this section:
  - 1. Plumbing fixtures.
  - 2. Electrical fixtures.

##### 1.02 REFERENCES

- A. ADA - Exposed Hot Water Pipes and Surfaces
- B. ANSI A208.2 - Fiberboard
- C. ASTM:
  - 1. D570 - Water Absorption of Plastics
  - 2. D635 - Rate and Extent of Burning of Plastics
  - 3. D638 - Tensile Properties of Plastics
  - 4. D695 - Compressive Properties of Rigid Plastics
  - 5. D785 - Rockwell Hardness of Plastics and Electrical Insulation Materials
  - 6. D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
  - 7. D792 - Density and Specific Gravity of Plastics
  - 8. G21 - Resistance of Synthetics to Fungi
- D. MCAA - Plumbing Standards
- E. Minnesota State Building Code: Chapter 1341 - Facilities for the Handicapped
- F. NEMA - NEMA LD3

##### 1.03 SYSTEM DESCRIPTION

- A. Performance Requirements:
  - 1. Metal Casework: Casework components shall withstand the following loads without damage:
    - a. Base unit: 500 pounds per lineal foot.
    - b. Suspended unit: 300 pounds.
    - c. Cabinet drawers: 150 pounds.

- d. Utility tables: 300 pounds.
- e. Hanging wall cases: 300 pounds.
- f. Shelves: 100 pounds.
- g. Casters: 300 pounds per caster.
- 2. Epoxy Resin Countertop:
  - a. Compressive strength (ASTM D695): 34,200 pounds per square inch.
  - b. Tensile strength (ASTM D638): 1850
  - c. Flexural strength (ASTM D790): 16,200 pounds per square inch.
  - d. Rockwell "M" hardness (ASTM D785): 111.
  - e. Density (ASTM D792): 2.03 g./cc.
  - f. Water absorption (ASTM D570): 0.004 percent
  - g. Fire Resistance (ASTM D635): ATB (sec) = 0.

#### **1.04 SUBMITTALS**

- A. Refer to Section 01 33 00.
- B. Product Data: Submit manufacturer's current Product Data including specifications, handling, storage and installation instructions, and maintenance recommendations.
- C. Shop Drawings:
  - 1. Submit Shop Drawings showing system fabrication, installation drawings, including plans, elevations, sections, details of components, joint locations and configurations within system and between system and adjoining system.
  - 2. Show location, size of each type of unit accessories, materials, finishes, hardware types and locations, fillers, etc.
  - 3. Indicate details of anchorage.
- D. Samples:
  - 1. Initial Color Selection: Submit manufacturer's standard color samples for each type of finish with Product Data and Shop Drawings.
  - 2. Color Verification: Prior to shipping, submit each type of finish indicated; in sets for each color, texture, and pattern specified, showing a full range of variations expected in these characteristics. Include notification to Engineer if selection is not within quoted price range.
  - 3. Components: Submit samples of anchors, fasteners, hardware, assembled corner sections and other materials and components if requested by Engineer.
- E. Quality Assurance/Control Submittals:
  - 1. Test Reports: Reports from independent testing laboratories approved by Engineer indicating compliance with the above performance requirements.
- F. Certificates:
  - 1. Product: Signed by manufacturers of casework certifying that products furnished comply with requirements.
  - 2. Manufacturer: Certificate of Compliance in AWI Quality Certification Program.
  - 3. Installer: From the manufacturer of casework.
- G. Maintenance Manual: Furnish Owner with maintenance and warranty data in "Maintenance Manual" at Maintenance Demonstration at Substantial Completion.

#### **1.05 QUALITY ASSURANCE**

- A. Casework Group: Manufacturer shall offer an integrated product line servicing the user function indicated with a coordinated design, supply, and installation of casework, equipment, work surfaces, and accessories:
  - 1. General casework.
  - 2. Laboratory.

- B. Qualifications:
  - 1. Manufacturer: 5 years' experience in the manufacture of manufactured casework, with 6 projects of similar size, scope and type of which 3 have been in successful use for 3 years or longer.
  - 2. Installer: 3 years' experience in the installation of manufactured casework.
  - 3. Personnel: For actual installation of manufactured casework, use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, thoroughly familiar with requirements of work.
- C. Regulatory Requirements for Cabinets:
  - 1. Comply with ANSI/KCMA A161.1 or A161.2 and provide cabinets with KCMA seal affixed in unexposed location of each unit, showing compliance.
- D. Field Samples: If requested, furnish sample of each type of manufactured casework to the Engineer for review prior to manufacture/installation. Engineer will forward approved sample to the Site for installation.

## 1.06 PROJECT CONDITIONS

- A. Environmental Requirements: Do not deliver to Site until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels for the remainder of the construction period.
- B. Field Measurements:
  - 1. Casework to fit to other construction:
    - a. Establish dimensions for areas where casework is to fit.
    - b. Coordinate to ensure actual dimensions correspond to established dimensions.
  - 2. Casework to fit to existing construction:
    - a. Verify dimensions of existing construction by field measurements before fabrication and indicate on Shop Drawings.
  - 3. Provide fillers and scribes to allow for trimming and fitting.
  - 4. Countertops: Verify dimensions after base cabinets are installed but before countertop fabrication is complete.
- C. Drawings do not purport to show actual field dimensions, but are intended only to establish location and scope of Work. Field-verify dimensions and assume full responsibility for their accuracy.

## 1.07 WARRANTY

- A. Furnish warranty from manufacturing defects and poor workmanship for a period of 5 years.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Metal Manufactured Casework:
  - 1. Standard of quality for design is based on MottLAB <https://www.mottlab.com>
  - 2. Other Acceptable Manufacturers: Subject to compliance with specified requirements, accepted manufacturers and products are:
    - a. Campbell Rhea, Paris, TN [www.campbellrhea.com](http://www.campbellrhea.com)
    - b. Dwyer, Wood Dale, IL [www.dwyerkitchens.com](http://www.dwyerkitchens.com)
    - c. Jamestown Metal Products by Lance Service, Inc., New Hope, MN [www.jamestown.com](http://www.jamestown.com)
    - d. Kewaunee Scientific, Statesville, NC [www.kewaunee.com](http://www.kewaunee.com)
    - e. Securall Products, LaPorte, IN [www.securallproducts.com](http://www.securallproducts.com)
    - f. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

- B. Countertop:
  - 1. Epoxy Resin:
    - a. Standard of Quality for design is based on Durcon (Wilsonart)  
www.wilsonartengineeredsurfaces.com
    - b. Other Acceptable Manufacturers: Subject to compliance with specified requirements, acceptable manufacturers and products are:
      - 1) Manufacturer of comparable products submitted in compliance with Section 01 25 13.

## 2.02 MATERIALS

- A. Metal Casework:
  - 1. Sheet steel, cold-rolled furniture stock.
  - 2. Gages:
    - a. 20-gage: Drawer bodies and heads, shelves, interior door panels, security panels and sloping tops.
    - b. 18-gage: Ends, backs, case tops and bottoms, bases, exterior door panels, and vertical posts.
    - c. 16-gage: Top front and intermediate rails, gussets, table legs, frames, leg rails, and stretchers.
    - d. 14-gage: Drawer suspensions, door and case hinge reinforcements, and L-shaped front corner gussets.
    - e. 11-gage: Table leg corner brackets and leveler gussets.
- B. Countertop:
  - 1. Epoxy Resin: Non-glaring, stain free, black surface, inert to all chemicals in normal laboratory use.
    - a. Sinks: Molded in one piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch (13-mm) minimum thickness.
      - 1) Provide with polypropylene strainers and tailpieces.
      - 2) Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
      - 3) Provide sinks for underside installation with manufacturer's recommended adjustable support system for table- and cabinet-type installations.

## 2.03 FABRICATION

- A. Metal Casework:
  - 1. General:
    - a. All members die-formed, notched, assembled in fixtures.
    - b. Exposed welds polished smooth.
    - c. Face corner intersections of vertical and horizontal members in same plane, with joints welded and polished.
    - d. Doors and drawer heads in same plane.
  - 2. Base Cabinets:
    - a. End panels and backs, formed of 1-piece, wrap-around design
    - b. Rear internal reinforcing channel with shelf clip adjustment holes.
    - c. Toe base structurally integral to cabinet body
    - d. Top front rail to interlock and overlap end panels with rabbeted offset for dust resistance.
    - e. Horizontal intermediate cross rails required for locks; recessed and concealed.
    - f. Support floor-mounted cabinets on 4 leveling screws.
    - g. Drawer bodies of welded construction with cove at bottom sides and flanged at topsides.
    - h. Drawer heads finished on all surfaces before assembly.
    - i. Bottoms of solid-panel 1-piece construction.
    - j. Front formed for door and drawer dust resistance.
  - 3. Wall cases formed of 1-piece, wrap-around design, with rear internal reinforcing channels containing shelf clip adjustment holes.
  - 4. Finish: Factory applied powder-coating.

- B. Countertops:
  - 1. Epoxy Resin Countertop:
    - a. Provide continuous tops for counter type cabinets fixed in a line as indicated on Drawings, or if not indicated, square nose, square splash, flat top, with drop-in epoxy resin sinks with coved corners and bottoms where indicated.
  - 2. Sink Cutouts:
    - a. Rout and sand cutouts for under-mounted sink or machine polish to form smooth edged openings with the top edge radius of 1/8 inch. Finish bottom edge of sink opening smooth with the edge broken to prevent sharpness.
    - b. Sink corner cutout radius to be not less than 1/4 inch.
    - c. Provide drip groove where indicated.
  - 3. Countertop Accessories:
    - a. Joint Sealant: 1 part polyurethane.

## 2.04 ACCESSORIES

- A. Epoxy drying rack sized as indicated on Drawings or, if not indicated, 30 inches by 36 inches.
- B. Other materials not specifically described but required for complete, proper installation of manufactured casework, subject to acceptance of Engineer.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Work of Other Trades: Prior to commencing work, carefully inspect and verify that work is complete to point where this installation may properly commence.
- B. Verification of Conditions: Verify that manufactured casework may be installed in accordance with original design, pertinent codes and regulations, and pertinent portions of referenced standards.
- C. Discrepancies:
  - 1. Immediately notify Engineer in writing.
  - 2. Do not proceed with installation in areas of discrepancy until fully resolved.
  - 3. Commencement of installation signifies acceptance of surface conditions.

### 3.02 PREPARATION

- A. Protection: Protect installed work and materials of other trades.
- B. Sequence of Operations: Install after painting, wet work, grinding and similar operations, which can be performed before installation, are completed.
- C. Coordination:
  - 1. Layout and installation of blocking and reinforcement in partitions for support of casework.
  - 2. Locations of utilities that will penetrate countertops or backsplashes.

### 3.03 INSTALLATION

- A. Install casework using factory-trained personnel experienced in installation of this type of equipment.
  - 1. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive, and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.
- B. Sink Installation: Sinks which were not factory installed shall be set in chemical resistant sealing compound and secured and supported per manufacturer's recommendations.



- C. Accessory Installation: Install accessories and fittings in accordance with manufacturer's recommendations. Turn screws to seat flat; do not drive.

**3.04 REPAIR/RESTORATION**

- A. Touch up marred finishes, but replace units that cannot be restored to factory-finished appearance, using materials, procedures recommended or furnished by manufacturer.

**3.05 ADJUSTING**

- A. Adjust units to operate in proper manner and easily without binding.

**3.06 CLEANING**

- A. Site:
  - 1. Do not allow accumulation of scraps, debris arising from work of this section.
  - 2. Maintain premises in neat, orderly condition.
- B. System:
  - 1. Clean exposed and semi-exposed surfaces of manufactured casework using materials and methods recommended by manufacturer.
  - 2. Leave surfaces clean and free from defects at time of final acceptance.

**3.07 DEMONSTRATION**

- A. Maintenance Instructions: Manufacturer's representative to schedule and attend meeting with Owner's Representative to explain:
  - 1. Maintenance and Care Instructions.
  - 2. Recommended Maintenance Program.
  - 3. Warranty Requirements.

**END OF SECTION**

## SECTION 22 07 19

### PLUMBING PIPING INSULATION

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  1. Domestic hot-water piping.
  2. Domestic cold-water piping.
  3. Recirculated hot-water piping.
  4. Tempered water.
  5. Sanitary waste piping exposed to freezing conditions.

##### 1.04 RELATED DOCUMENTS

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

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

##### 1.06 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.07 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 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.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  1. Supply and Drain Protective Shielding Guards: ICC A117.1.

## **PART 2 PRODUCTS**

### **2.01 INSULATION MATERIALS**

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping 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 C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Manufacturers:
    - a. Knauf.
    - b. Johns Manville.
    - c. Owens Corning.
    - d. Certainteed.
  - 2. Type I, 850 degrees F (454 degrees C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

### **2.02 INSULATING CEMENTS**

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

### **2.03 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. 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).
  - 2. 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. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. 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. 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. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. 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. 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."

## 2.04 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. Water-Vapor Permeance: ASTM E96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 degrees F (Minus 29 to plus 82 degrees C).
  - 3. Solids Content: ASTM D1644, 58 percent by volume and 70 percent by weight.
  - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 degrees F (Minus 29 to plus 82 degrees C).
  - 3. Solids Content: 60 percent by volume and 66 percent by weight.
  - 4. Color: White.

## 2.05 SEALANTS

- A. Joint Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Permanently flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 100 to plus 300 degrees F (Minus 73 to plus 149 degrees C).
  - 4. Color: White or gray.
  - 5. 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).
  - 6. 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. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 degrees F (Minus 40 to plus 121 degrees C).
  - 4. Color: Aluminum.
  - 5. 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).
  - 6. 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. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 degrees F (Minus 40 to plus 121 degrees C).
  - 4. Color: White.
  - 5. 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).
  - 6. 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."

## 2.06 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 C1136, Type I.
  - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
  - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

## 2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, 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. Adhesive: As recommended by jacket material manufacturer.
  - 2. Color: White.
  - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, 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.

## 2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
  - 1. Width: 3 inches (75 mm).
  - 2. Thickness: 11.5 mils (0.29 mm).
  - 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  - 6. 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 C1136.
  - 1. Width: 3 inches (75 mm).
  - 2. Thickness: 6.5 mils (0.16 mm).
  - 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  - 6. 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. Width: 2 inches (50 mm).
  - 2. Thickness: 6 mils (0.15 mm).
  - 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
  - 4. Elongation: 500 percent.
  - 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

## 2.09 SECUREMENTS

- A. Aluminum Bands: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch (19-mm) wide, stainless steel or Monel.
- C. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

## **2.10 PROTECTIVE SHIELDING GUARDS**

- A. Protective Shielding Pipe Covers:
  - 1. 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. 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**

### **3.01 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.

### **3.02 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. Provide continuous vapor barrier on all below ambient piping.
- 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. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- D. Install multiple layers of insulation with longitudinal and end seams staggered.
- E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- 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 pipe 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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm)] [4 inches (100 mm)] 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.
- 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 (100 mm) 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.
  4. Cleanouts.

### 3.03 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 (50 mm) 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 (50 mm).
  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 Division 7.
- 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 Division 7.

### 3.04 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. Fiberglass insert (thickness to be consistent with adjacent pipe insulation) with pre-formed PVC fitting covers secured with stainless steel tacks and PVC tape is also acceptable.
  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 (50 mm) 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.

### **3.05 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE 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 (150 mm) 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 (25 mm), 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.

### **3.06 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 (38-mm) laps at longitudinal seams and 3-inch (75-mm) 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 (25-mm) 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.
- C. Where metal jackets are indicated, install with 2-inch (50-mm) 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 (300 mm) o.c. and at end joints.

### **3.07 FINISHES**

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9.
  1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- 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.

### **3.08 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  1. Inspect pipe, fittings, strainers, and valves, 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 three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### **3.09 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. Continuous vapor barrier shall be provided on all below ambient piping.
- 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.

### **3.10 INDOOR PIPING INSULATION SCHEDULE**

- A. Domestic Hot, Domestic Cold, Recirculated hot-water, Tempered water, and Non-Potable water: Insulation shall be the following:
  - 1. Mineral-Fiber, Preformed Pipe Insulation, Type I with factory ASJ-SSL jacket: 1 inch (25 mm) thick. Continuous vapor barrier.

**END OF SECTION**

## SECTION 22 11 16

### DOMESTIC WATER PIPING AND VALVES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  - 1. Aboveground domestic water pipes, tubes, and fittings inside buildings.
  - 2. Encasement for piping.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, transition fittings, dielectric fittings, and accessories.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

#### PART 2 PRODUCTS

##### 2.01 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 Annex G. Plastic piping components shall be marked with "NSF-pw."

##### 2.02 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.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

- F. Copper Unions:
  1. MSS SP-123.
  2. Cast-copper-alloy, hexagonal-stock body.
  3. Ball-and-socket, metal-to-metal seating surfaces.
  4. Solder-joint or threaded ends.
- G. Copper-Tube, Extruded-Tee Connections:
  1. Description: Tee formed in copper tube according to ASTM F2014.

### **2.03 PVC PIPE AND FITTINGS**

- A. PVC Pipe: ASTM D 1785, Schedule 80.
- B. PVC Socket Fittings: ASTM D2467 for Schedule 80.
- C. PVC Schedule 80 Threaded Fittings: ASTM D2464.

### **2.04 CPVC PIPE AND FITTINGS**

- A. CPVC Pipe: Schedule 80 pressure pipe with schedule 80 fittings and appurtenances to locations shown on the drawings. Pipe shall meet the requirements of ASTM D2846/D2846M and ASTM F441/F441M.
  1. Fittings: ASTM D 1784, CPVC socket type fittings. Fittings shall have the same pressure and temperature rating as the pipe and shall comply with ASTM 439.
  2. Joints: Pipe 2 inches and smaller shall be ASTM D2864/D2846M, solvent welded with ASTM F493 solvent cement or flanged.
  3. Flanges for piping 2 inches and larger: 150-pound socket Type CPVC flange. Use flat full faced natural rubber gaskets at flanged connections. Furnish heavy hex bolts, each one with heavy hex nut, ASTM F593 Type 316 Stainless Steel.

### **2.05 STAINLESS-STEEL PIPING**

- A. Potable-water piping and components shall comply with NSF 61 Annex G.
- B. Stainless-Steel Pipe: ASTM A312/A312M, Schedule 10 and Schedule 40.
- C. Stainless-Steel Pipe Fittings: ASTM A815/A 815M.
- D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
  1. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
  2. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:
    - a. AWWA C606 for stainless-steel-pipe dimensions.
    - b. Stainless-steel housing sections.
    - c. Stainless-steel bolts and nuts.
    - d. EPDM-rubber gaskets suitable for hot and cold water.
    - e. Minimum Pressure Rating:
      - 1) NPS 8 and Smaller: 600 psig.

### **2.06 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 B32, lead-free alloys.

- D. Flux: ASTM B813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer according to ASTM F656.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Solvent cement and adhesive primer 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. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.07 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.
- D. Plastic-to-Metal Transition Fittings:
  - 1. Description:
    - a. PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
    - b. One end with threaded brass insert and one solvent-cement-socket end.
- E. Plastic-to-Metal Transition Unions:
  - 1. Description:
    - a. PVC four-part union.
    - b. Brass or stainless-steel threaded end.
    - c. Solvent-cement-joint plastic end.
    - d. Rubber O-ring.
    - e. Union nut.

## 2.08 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.
- B. Dielectric Unions:
  - 1. Standard: ASSE 1079.
  - 2. Pressure Rating: 125 psig minimum at 180 degrees F.
  - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  - 1. Standard: ASSE 1079.
  - 2. Factory-fabricated, bolted, companion-flange assembly.
  - 3. Pressure Rating: 125 psig minimum at 180 degrees F.
  - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

- D. Dielectric-Flange Insulating Kits:
  1. Nonconducting materials for field assembly of companion flanges.
  2. Pressure Rating: 150 psig.
  3. Gasket: Neoprene or phenolic.
  4. Bolt Sleeves: Phenolic or polyethylene.
  5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
  1. Standard: IAPMO PS 66.
  2. Electroplated steel nipple complying with ASTM F1545.
  3. Pressure Rating and Temperature: 300 psig at 225 degrees F.
  4. End Connections: Male threaded or grooved.
  5. Lining: Inert and noncorrosive, propylene.

## 2.09 GENERAL DUTY VALVES

- A. Manufacturers:
  1. Milwaukee.
  2. Nibco.
  3. Apollo.
- B. Gate Valves:
  1. Up to and including 3 inches: MSS SP-80, Class 150, lead free, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder or threaded ends.
- C. Globe Valves:
  1. Up to and including 3 inches: MSS SP-80, Class 150, lead free, bronze body, bronze trim, hand-wheel, Teflon disc, solder or threaded ends.
- D. Ball Valves:
  1. Up to and including 3 inches: MSS-SP-110, Class 150, 400 psi CWP, lead free bronze, two-piece body, stainless steel ball, full port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.
- E. Swing Check Valves:
  1. Up to and including 2 inches: MSS-SP-80, Class 150, lead free, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.
- F. Water Pressure Reducing Valves:
  1. Up to and including 2 inches: MSS-SP-80, lead free, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.

## PART 3 EXECUTION

### 3.01 EARTHWORK

- A. Comply with requirements in Division 31.

### 3.02 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.
  1. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

- 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. Install shutoff valve immediately upstream of each dielectric fitting.
- C. Install domestic water piping level and plumb.
- D. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- F. 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.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- H. Install piping to permit valve servicing.
- I. 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.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- M. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump.
- N. Install thermostats in hot-water circulation piping.
- O. Install thermometers on inlet and outlet piping from each water heater.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.03 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 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 B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- F. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. 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.
- G. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- H. 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.
- I. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  - 2. PVC Piping: Join according to ASTM D2855.
- J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

#### **3.04 TRANSITION FITTING INSTALLATION**

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2" and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2" and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2" and Smaller: Plastic-to-metal transition fittings or unions.

#### **3.05 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 couplings.

#### **3.06 HANGER AND SUPPORT INSTALLATION**

- A. Comply with requirements for pipe hanger, support products, and installation in Section 23 05 29.
  - 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.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
- G. Install supports for vertical PVC piping every 48 inches.
- H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

### 3.07 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 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.

### 3.08 IDENTIFICATION

- A. Identify system components.
- B. Label pressure piping with system operating pressure.

### 3.09 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. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  2. Piping Tests:
  3. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  4. 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.

5. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  6. Provide air test for all metal piping and provide hydrostatic test for all thermoplastic piping in accordance with Wisconsin plumbing code.
  7. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  8. All plumbing piping shall be tested twice. The first test shall be upon rough piping installation. The second test shall be upon final completion. A manometer test is required at the time of finished plumbing inspection.
  9. All testing shall be in accordance with current WI plumbing code and all other pertinent local codes and standards.
  10. 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.
  6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  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.

### 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 unless otherwise indicated.

- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Aboveground domestic water piping (all areas except chemical rooms), NPS 2 and smaller, shall be the following:
  - 1. Hard copper tube, ASTM B88, Type L ASTM B88; cast- or wrought-copper, solder-joint fittings; and soldered joints.
- E. Aboveground domestic water piping (chemical rooms), NPS 2 and smaller, shall be one of the following:
  - 1. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
  - 2. Stainless Steel, Schedule 10; grooved end; mechanical couplings.

### **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 or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
  - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
  - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
  - 4. Drain Duty: Hose-end drain valves.
  - 5. Provide PVC valves for all PVC piping systems and CPVC valves for all CPVC piping systems.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

**END OF SECTION**

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## SECTION 22 11 19

### DOMESTIC WATER PIPING SPECIALTIES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Vacuum breakers.
  2. Backflow preventers.
  3. Temperature-actuated, water mixing valves.
  4. Strainers.
  5. Hose bibbs.
  6. Wall hydrants.
  7. Drain valves.
  8. Water meters.
  9. Water pressure reducing valves.
  10. Water hammer arrestor.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### PART 2 PRODUCTS

##### 2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G.

##### 2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

##### 2.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

## 2.04 BACKFLOW PREVENTERS

A. Manufacturers:

1. Watts
2. Zurn
3. Conbraco

B. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 (DN 50) and smaller; stainless steel for NPS 2-1/2 (DN 65) and larger.
5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Lead free.
8. Accessories:
  - a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
  - b. Valves NPS 2-1/2 (DN 65) and Larger: Non-rising stem-gate type with flanged ends on inlet and outlet.
  - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
  - d. Inlet strainer

## 2.05 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Manufacturers:

1. Lawler.
2. Leonard Valve.
3. Zurn.

B. Primary, Thermostatic, Water Mixing Valves:

1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
3. Type: Cabinet-type, thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.
6. Accessories: Manual temperature control, strainer check stops on hot- and cold-water supplies, and adjustable, temperature-control handle, stem thermometer on outlet, outlet ball valve.
7. Valve Finish: Chrome plated.
8. Piping Finish: Copper.
9. Cabinet: Factory fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.

## 2.06 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.

2. Body: Bronze for NPS 2 (DN 50) 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 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
  - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
6. Drain: Factory-installed, hose-end drain valve.

## 2.07 HOSE BIBBS

- A. Manufacturers:
  1. Woodford.
  2. Watts.
  3. Zurn.
- B. Hose Bibbs:
  1. Standard: ASME A112.18.1 for sediment faucets.
  2. Body Material: Bronze.
  3. Seat: Bronze, replaceable.
  4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
  5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
  6. Pressure Rating: 125 psig (860 kPa).
  7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
  8. Finish for Equipment Rooms: Chrome or nickel plated.
  9. Finish for Service Areas: Chrome or nickel plated.
  10. Finish for Finished Rooms: Chrome or nickel plated.
  11. Operation for Equipment Rooms: Wheel handle or operating key.
  12. Operation for Service Areas: Wheel handle.
  13. Operation for Finished Rooms: Wheel handle.
  14. Include operating key with each operating-key hose bibb.
  15. Include wall flange with each chrome- or nickel-plated hose bibb.

## 2.08 WALL HYDRANTS

- A. Manufacturers:
  1. Woodford
  2. Watts
  3. Zurn
- B. Nonfreeze Wall Hydrants:
  1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
  2. Pressure Rating: 125 psig (860 kPa).
  3. Operation: Loose key.
  4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
  5. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
  6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
  7. Box: Deep, flush mounted with cover.
  8. Box and Cover Finish: Chrome plated.
  9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
  10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
  11. Operating Keys(s): Two with each wall hydrant.



## 2.09 DRAIN VALVES

- A. Manufacturers:
  - 1. Milwaukee.
  - 2. Nibco.
  - 3. Conbraco.
  
- B. Ball-Valve-Type, Hose-End Drain Valves:
  - 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
  - 2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
  - 3. Size: NPS 3/4 (DN 20).
  - 4. Body: Copper alloy.
  - 5. Ball: Chrome-plated brass.
  - 6. Seats and Seals: Replaceable.
  - 7. Handle: Vinyl-covered steel.
  - 8. Inlet: Threaded or solder joint.
  - 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.10 DISPLACEMENT-TYPE WATER METERS:

- A. Standard: AWWA C700.
- B. Pressure Rating: 150-psig (1035-kPa) working pressure.
- C. Body Design: Nutating disc; totalization meter.
- D. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
- E. Case: Bronze.
- F. End Connections: Threaded.
- G. Water meter will be provided by Owner and installed by the Contractor.

## 2.11 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators:
  - 1. Manufacturer's:
    - a. Apollo
    - b. Watts
    - c. Zurn
      - 1) Standard: ASSE 1003.
      - 2) Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
      - 3) Design Flow Rate: Refer to drawings.
      - 4) Design Inlet Pressure: Refer to drawings.
      - 5) Design Outlet Pressure Setting: Refer to drawings.
      - 6) Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
      - 7) End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

## 2.12 WATER-HAMMER ARRESTORS

- A. Manufacturers:
  - 1. Josam
  - 2. Amtrol
  - 3. Mifab

- B. Water-Hammer Arresters:
  - 1. Standard: ASSE 1010 or PDI-WH 201.
  - 2. Type: Metal bellows.
  - 3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.
  - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  - 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- D. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve and pump.
- E. Install water-hammer arresters in water piping according to PDI-WH 201.
- F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- G. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

### **3.02 CONNECTIONS**

- A. Comply with requirements for ground equipment in Division 26.
- B. Fire-retardant-treated-wood blocking is specified in Division 26.

### **3.03 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
  - 1. Prepare test and inspection reports.

### **3.04 ADJUSTING**

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

**END OF SECTION**

## SECTION 22 11 20

### PLUMBING FIXTURES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Water closets.
  2. Lavatories.
  3. Mop Basins.
  4. Emergency Showers.
  5. Eye and Face Wash Fountains.
  6. Laboratory Sinks.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include sizes, characteristics, accessories, trim, and finishes.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

##### 1.06 QUALITY ASSURANCE

- A. Products requiring electrical connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

#### PART 2 PRODUCTS

##### 2.01 WATER CLOSETS

- A. Manufacturers:
  1. American Standard.
  2. Kohler.
  3. Crane.
  4. Zurn.
  5. Or approved equal
- B. Description: Floor mounted, top outlet, elongated flushometer valve toilet. Vitreous china. Anti-mold surface. Condensation channel. Top spud. Siphon jet action. Fully glazed trapway. ADA compliant. White color with white bolt covers.
- C. Seat: Solid white plastic open front seat with self-sustaining check hinge.

- D. Flush Valve: Manual piston type with ADA compliant non-hold open handle. Chrome plated cast brass construction. 1.6 gallon per flush.

## **2.02 WALL MOUNTED LAVATORIES**

- A. Manufacturers:
  - 1. American Standard.
  - 2. Kohler.
  - 3. Crane.
  - 4. Zurn.
  - 5. Or approved equal
- B. Description: Wall hung, rectangular, ADA compliant. Vitreous china, with back. Top faucet holes on 4-inch centers. White color. 6-1/2-inch bowl depth. Brass P trap with ADA trap wrap.
- C. Supplies: Chrome plated copper with angle stops.
- D. Drain: Grid with offset waste. Chrome plated, cast brass p-trap, tubular brass waste to wall and wall escutcheon. Provide ADA trap wrap insulation.
- E. Faucet: Chrome plated, two handle centerset faucet with wrist blade handles and grid strainer drain. 0.5 gpm. ADA compliant. Individual faucet mixing valve.
- F. Carrier: ASME A112.6M. Type II lavatory carrier.

## **2.03 MOP BASINS**

- A. Manufacturers:
  - 1. Mustee.
  - 2. Fiat.
  - 3. Or approved equal.
- B. Description: One piece molded structural fiberglass mop basin. Integral 3-inch drain with removable stainless steel strainer.
- C. Overall Dimensions (L by W): 24-inch by 24-inch.
- D. Height: 10 inches.
- E. Faucet: Chrome plated dual handle sink faucet with hose thread outlet, integral stop valves, atmospheric vacuum breaker, round wall escutcheons, 2-3/8-inch vandal proof lever handles.

## **2.04 EMERGENCY EYE AND FACE WASH**

- A. Manufacturers:
  - 1. Guardian.
  - 2. Bradley.
  - 3. Haws.
  - 4. Or approved equal
- B. Description: ANSI Z358.1; corrosion resistant, free standing, self-cleaning, non-clogging eye and face wash with quick opening, full flow valves, impact resistant plastic eye and face wash receptor, twin soft flow eye wash heads and face spray ring, stainless steel dust cover, PVC coated control valve and fittings.

## **2.05 EMERGENCY SHOWER**

- A. Manufacturers:

1. Guardian.
2. Bradley.
3. Haws.
4. Or approved equal.

B. Description: ANSI Z358.1; corrosion resistant, free standing, self-cleaning, non-clogging 10-inch diameter, impact resistant plastic deluge shower head with elbow, one inch PVC coated full flow valve with PVC coated pull chain, 8-inch diameter ring, one inch interconnecting fittings.

## **2.06 EPOXY LABORATORY SINKS (SK-1 PROVIDED BY COUNTERTOP SUPPLIER)**

- A. Description: Epoxy undermount single-compartment laboratory sink provided by laboratory countertop supplier to match countertop surface.
- B. Overall Dimensions (LxW): 14"x14"
- C. Bowl Depth: 5" ADA depth.
- D. Drain: 1-1/2" Spears CPVC laboratory drain and waste. Center-rear drain location.
- E. Faucet: Chrome plated, gooseneck laboratory faucet. 1.5 gpm. ADA compliant.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures

### **3.02 PREPARATION**

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture schedule.

### **3.03 INSTALLATION**

- A. Assemble plumbing fixtures, trim, fittings, and other components per manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
  1. Use chair type with waste fitting and seal for back-outlet fixtures.
  2. Use chair type without waste fitting for fixtures with tubular waste piping.
- 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 fixtures level and plumb per roughing-in drawings.
- F. 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.
- G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- I. Install toilet seats on water closets.

- J. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- K. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- L. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- 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 and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.
- O. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

**END OF SECTION**

## SECTION 22 13 13

### FIRE PROTECTION SYSTEMS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Steel Pipes, fittings, and specialties.
  - 2. Ductile Iron Pipes, fittings, and specialties
  - 3. Listed Fire Protection Valves
  - 4. Trim and Drain Valves
  - 5. Specialty valves.
  - 6. Sprinkler Piping Specialties
  - 7. Fire Department Connections
  - 8. Sprinklers.
  - 9. Alarm devices.
  - 10. Pressure gages.
  - 11. Dry Pipe System
- B. Related Requirements:
  - 1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
  - 2. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

##### 1.03 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe and Dry-pipe sprinkler system piping designed to operate at working pressure of 175-psig (1200-kPa) maximum.

##### 1.04 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 and dry-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.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and professional engineer.
- B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- C. Welding certificates.
- D. Fire-hydrant flow test report.



- E. 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."
- F. Field quality-control reports.

## 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

## 1.07 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.

## 1.08 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 2010 ASME Boiler and Pressure Vessel Code.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
  - 1. NFPA 13.
- B. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer to design wet-pipe and dry-pipe sprinkler systems.
  - 1. Sprinkler system design shall be approved by authorities having jurisdiction.
    - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
    - b. Sprinkler Occupancy Hazard Classifications:
      - 1) Building Service Areas: Ordinary Hazard, Group 1.
      - 2) Electrical Equipment and Generator Rooms: Ordinary Hazard, Group 1.
      - 3) General Storage Areas: Ordinary Hazard, Group 1.
      - 4) Chemical Storage Areas: Ordinary Hazard, Group 2.
      - 5) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
      - 6) Office and Public Areas: Light Hazard.
  - 2. Minimum Density for Automatic-Sprinkler Piping Design:
    - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.

- b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139 sq. m) area.
  - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139 sq. m) area.
  - d. Special Occupancy Hazard: As determined by authorities having jurisdiction.
3. Maximum Protection Area per Sprinkler: According to UL listing.
- D. Refer to 2.12 for dry-pipe system.

## 2.02 STEEL PIPE AND FITTINGS

- A. Schedule 40, 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. Malleable- or Ductile-Iron Unions: UL 860.
- C. Cast-Iron Flanges: ASME 16.1, Class 125.
- D. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
  - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free
    - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
    - 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.
- E. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
  - 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.
- F. Grooved-Joint, Steel-Pipe Appurtenances:
  - 1. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 2. Painted Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
  - 3. 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 bolts and nuts.

## 2.03 DUCTILE-IRON PIPE AND FITTINGS

- A. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
- B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.
- C. Grooved-End, Ductile-Iron Pipe Appurtenances:
  - 1. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
  - 2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- E. Flanges: ASME B16.1, Class 125, cast iron.

## 2.04 LISTED FIRE PROTECTION VALVES

- A. General Requirements:
  - 1. Valves shall be UL listed or FM approved.

2. Minimum pressure rating for standard pressure piping: 175 PSI
- B. Ball Valves:
1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
  2. Valves NPS 1-1/2" and Smaller: Bronze body with threaded ends.
  3. Valves NPS 2 and 2-1/2": Bronze body with threaded ends or ductile iron body with grooved ends.
  4. Valves NPS 3: Ductile-iron body with grooved ends.
- C. Bronze Butterfly Valves:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
  2. Pressure Rating: 175 psig.
  3. Body Material: Cast or ductile iron.
  4. Style: Lug or wafer.
  5. End Connections: Grooved
- D. Iron Butterfly Valves:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
  2. Pressure Rating: 175
  3. Body Material: Cast or ductile iron.
  4. Style: Lug or wafer.
  5. End connections: Grooved.
- E. Bronze OS&Y Gate Valves:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
  2. Pressure Rating: 175 psig
  3. Body Material: Bronze
  4. End Connections: Threaded
- F. Indicating Type Butterfly Valves:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
  2. Pressure Rating: 175 psig
  3. Valves NPS 2 and smaller:
    - a. Valve Type: Ball or butterfly
    - b. Body Material: Bronze
    - c. End Connections: Threaded.
  4. Valves NPS 2-1/2 and Larger:
    - a. Valve Type: Butterfly
    - b. Body Material: Cast or ductile iron
    - c. End connections: Flanged, grooved, or wafer.
  5. Valve Operation: Integral electrical, 115 v-ac, pre-wired, two-circuit, supervisory switch indicating device.
- G. Check Valves
1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
  2. Minimum Pressure Rating: 175 psig (1200 kPa).
  3. Type: Single swing check.
  4. Body Material: Cast iron, ductile iron, or bronze.
  5. Clapper: Bronze, ductile iron, or stainless steel[ **with elastomeric seal**].
  6. Clapper Seat: Brass, bronze, or stainless steel.
  7. Hinge Shaft: Bronze or stainless steel.
  8. Hinge Spring: Stainless steel.
  9. End Connections: Flanged, grooved, or threaded.

- H. Indicator Posts
  - 1. Standard: UL 789 and FM Global standard for indicator posts.
  - 2. Type: Wall.
  - 3. Base Barrel Material: Cast or ductile iron.
  - 4. Extension Barrel: Cast or ductile iron.
  - 5. Cap: Cast or ductile iron.
  - 6. Operation: Handwheel

## 2.05 TRIM AND DRAIN VALVES

- A. General Requirements:
  - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide" published by FM Global, listing.
  - 2. Pressure Rating: 175 psig minimum.

## 2.06 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
  - 1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
  - 1. Standard: UL 193.
  - 2. Design: For horizontal or vertical installation.
  - 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
  - 4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
  - 5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
  - 6. 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.
- G. Automatic (Ball Drip) Drain Valves:
  - 1. Standard: UL 1726.
  - 2. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 3. Type: Automatic draining, ball check.
  - 4. Size: NPS 3/4 (DN 20).
  - 5. End Connections: Threaded.
- H. Double-Check, Detector-Assembly Backflow Preventers:
  - 1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
  - 2. Operation: Continuous-pressure applications.
  - 3. Pressure Loss: 5 psig (35 kPa) maximum, through middle one-third of flow range.
  - 4. Body Material: Stainless steel.
  - 5. End Connections: Flanged.
  - 6. Configuration: Designed for vertical flow.
  - 7. Accessories:
    - a. Valves: UL 262 and FM Global's "Approval Guide" listing; OS&Y gate type with flanged ends on inlet and outlet.

## 2.07 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
  - 1. Standard: UL 213.
  - 2. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  - 4. Type: Mechanical-tee and -cross fittings.
  - 5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
  - 6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
  - 7. Branch Outlets: Grooved, plain-end pipe, or threaded.
  
- B. Flow Detection and Test Assemblies:
  - 1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  - 2. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
  - 4. Size: Same as connected piping.
  - 5. Inlet and Outlet: Threaded or grooved.
  
- C. Branch Line Testers:
  - 1. Standard: UL 199.
  - 2. Pressure Rating: 175 psig (1200 kPa).
  - 3. Body Material: Brass.
  - 4. Size: Same as connected piping.
  - 5. Inlet: Threaded.
  - 6. Drain Outlet: Threaded and capped.
  - 7. Branch Outlet: Threaded, for sprinkler.
  
- D. Sprinkler Inspector's Test Fittings:
  - 1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  - 2. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 3. Body Material: Cast- or ductile-iron housing with sight glass.
  - 4. Size: Same as connected piping.
  - 5. Inlet and Outlet: Threaded.
  
- E. Adjustable Drop Nipples:
  - 1. Standard: UL 1474.
  - 2. Pressure Rating: 250-psig (1725-kPa) minimum.
  - 3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
  - 4. Size: Same as connected piping.
  - 5. Length: Adjustable.
  - 6. Inlet and Outlet: Threaded.
  
- F. Flexible Sprinkler Hose Fittings:
  - 1. Standard: UL 1474.
  - 2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
  - 3. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 4. Size: Same as connected piping, for sprinkler.

## 2.08 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

- A. Standard: UL 405.
  
- B. Type: Flush, for wall mounting.
  
- C. Pressure Rating: 175 psig (1200 kPa) minimum.
  
- D. Body Material: Corrosion-resistant metal.

- E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: Rectangular, brass, wall type.
- H. Outlet: With pipe threads.
- I. Body Style: Horizontal.
- J. Number of Inlets: Two.
- K. Outlet Location: Back.
- L. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- M. Finish: Rough brass or bronze.
- N. Outlet Size: Per NFPA 13.

## **2.09 SPRINKLERS**

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
  1. Nonresidential Applications: UL 199.
  2. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Sprinkler Finishes: Chrome plated bronze and painted.
- E. Special Coatings: Wax.
- F. 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.
- G. Sprinkler Guards:
  1. Standard: UL 199.
  2. Type: Wire cage with fastening device for attaching to sprinkler.

## **2.10 ALARM DEVICES**

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
  1. Standard: UL 753.
  2. Type: Mechanically operated, with Pelton wheel.
  3. Alarm Gong: Cast aluminum with red-enamel factory finish.
  4. Size: 8-1/2-inches (216-mm) diameter.
  5. Components: Shaft length, bearings, and sleeve to suit wall construction.
  6. Inlet: NPS 3/4 (DN 20).
  7. Outlet: NPS 1 (DN 25) drain connection.

- C. Electrically Operated Alarm Bell:
  1. Standard: UL 464.
  2. Type: Vibrating, metal alarm bell.
  3. Size: 6-inch (150-mm) minimum- diameter.
  4. Finish: Red-enamel factory finish, suitable for outdoor use.
  5. 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. Water-Flow Indicators:
  1. Standard: UL 346.
  2. Water-Flow Detector: Electrically supervised.
  3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
  4. Type: Paddle operated.
  5. Pressure Rating: 250 psig (1725 kPa).
  6. Design Installation: Horizontal or vertical.
  
- E. Pressure Switches:
  1. Standard: UL 346.
  2. Type: Electrically supervised water-flow switch with retard feature.
  3. Components: Single-pole, double-throw switch with normally closed contacts.
  4. Design Operation: Rising pressure signals water flow.
  
- F. Valve Supervisory Switches:
  1. Standard: UL 346.
  2. Type: Electrically supervised.
  3. Components: Single-pole, double-throw switch with normally closed contacts.
  4. Design: Signals that controlled valve is in other than fully open position.
  5. 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.

## 2.11 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gage Range: 0- to 250-psig (0- to 1725-kPa) minimum.
- D. Label: Include "WATER" label on dial face.
- E. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

## 2.12 DRY PIPE SYSTEM

- A. Fittings and Sprinklers are as specified elsewhere in Part 2 of this specification. Gaskets shall be suitable for use in dry pipe systems.
- B. Steel Pipe: Standard-Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- C. Dry-Pipe Valves:
  1. Standard: UL 260.
  2. Design: Differential-pressure type.
  3. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

- D. Pressure Switches:
  1. Standard: UL 346.
  2. Type: Electrically supervised water-flow switch with retard feature.
  3. Components: Single-pole, double-throw switch with normally closed contacts.
  4. Design Operation: Rising pressure signals water flow.
  
- E. Valve Supervisory Switches:
  1. Standard: UL 346.
  2. Type: Electrically supervised.
  3. Components: Single-pole, double-throw switch with normally closed contacts.
  4. Design: Signals that controlled valve is in other than fully open position.
  5. 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.
  
- F. Air-Pressure Maintenance Device:
  1. Standard: UL 260.
  2. Type: Automatic device to maintain minimum air pressure in piping.
  3. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175 psig outlet pressure.
  
- G. Air Compressor:
  1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  2. Motor Horsepower: Fractional.
  3. Power: 120-V ac, 60 Hz, single phase.
  4. Accessories:
    - a. Inlet filters
    - b. Safety valve
    - c. Pressure switch
    - d. Check valve
    - e. Tubing and fittings

## **PART 3 EXECUTION**

### **3.01 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.

### **3.02 SERVICE-ENTRANCE PIPING**

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- 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.

### **3.03 PIPING INSTALLATION**

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
  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.



2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
  - C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
  - D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
  - E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
  - F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
  - G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
  - H. Install sprinkler piping with drains for complete system drainage.
  - I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
  - J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
  - K. Install alarm devices in piping systems.
  - L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
  - M. 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 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
  - N. Fill sprinkler system piping with water.
  - O. Drain dry-pipe sprinkler piping.
  - P. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices, air compressors.
  - Q. Install sleeves for piping penetrations of walls, ceilings, and floors.
  - R. Install sleeve seals for piping penetrations of concrete walls and slabs.
  - S. Install escutcheons for piping penetrations of walls, ceilings, and floors.
  - T. Install auxiliary dry pipe system by manifolding off wet sprinkler system riser for generator room.
  - U. Install supervisory switch on dry pipe system.
  - V. Connect compressed-air supply to dry-pipe sprinkler piping.
  - W. Connect air compressor to the following piping and wiring:
    1. Pressure gages and controls.

2. Electrical power system.
3. Fire-alarm devices, including low-pressure alarm.

### 3.04 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 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) 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. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. 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.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-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 joints.
- L. 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.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- P. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

- Q. 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.
- R. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### **3.05 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. Install valves in vertical position for proper direction of flow, in main supply to system.
  - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
  - 3. Install dry-pipe valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
    - a. Install air compressor and compressed-air-supply piping.
    - b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range; and 175-psig (1200-kPa) maximum inlet pressure.

### **3.06 SPRINKLER INSTALLATION**

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.
- C. Install high temperature sprinklers in close vicinity with unit heaters.
- D. Install sprinklers under exposed ductwork over 48-inches wide and under exposed groups of piping over 48-inches wide.
- E. Install wire guards on sprinklers that may be subject to damage.

### **3.07 RISER ASSEMBLY**

- A. Connect to water service from finished water main in building.
- B. Pipe main drain to outside with elbow turned downward, having at least four feet of interior piping beyond valve.
- C. On Fire Department Connection maintain a minimum of four feet of pipe between exterior wall and check valve at section of piping containing water. Locate and arrange fire department connection so that hose can be readily and conveniently attached. Mount at 1'-6" minimum to 48-inches maximum above grade.

### **3.08 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 Division 26.

### **3.09 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  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. Coordinate with fire-alarm tests. Operate as required.
  6. Coordinate with fire-pump tests. Operate as required.
  7. 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.

### **3.10 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.
- C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

### **3.11 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. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
  1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  3. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
  1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- F. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  3. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- G. Underground fire-suppression water-service piping NPS 3 and larger (DN 80) shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
  2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
- H. Standard-pressure, dry-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight, galvanized-steel pipe with plain ends; plain-end-pipe fittings; and twist-locked joints.
  3. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- I. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

### **3.12 SPRINKLER SCHEDULE**

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
  2. Rooms with Suspended Ceilings: Recessed sprinklers.
  3. Wall Mounting: Sidewall sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
  2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
  3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
  4. Residential Sprinklers: Dull chrome.
  5. 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**

## SECTION 22 13 16

### SANITARY WASTE AND VENT PIPING

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  - 1. Pipe, tube, and fittings.
  - 2. Specialty pipe fittings.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

##### 1.05 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

#### PART 2 PRODUCTS

##### 2.01 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.

##### 2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A74, Service class.
- B. Gaskets: ASTM C564, rubber.

##### 2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
  - 1. Standards: ASTM C1277 and CISPI 310.
  - 2. 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. Standards: ASTM C1277 and ASTM C1540.
  - 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

## 2.04 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
- B. Pressure Rated PVC Pipe: ASTM D1785, Schedule 40.
- C. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.
- D. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F656.
  - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer 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. Solvent Cement: ASTM D2564.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Solvent cement 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."

## 2.05 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, Nonpressure Transition Couplings:
    - a. Standard: ASTM C1173.
    - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - c. Sleeve Materials:
      - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
      - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
      - 3) For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
  - 4. Shielded, Nonpressure Transition Couplings:
    - a. Standard: ASTM C1460.
    - b. 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

### 3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

### 3.02 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 at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. 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.
- I. Lay buried building 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.
- J. 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 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) 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.
- K. 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."
- L. Install aboveground PVC piping according to ASTM D2665.
- M. Install underground PVC piping according to ASTM D2321.
- N. Plumbing Specialties:
  - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
  - 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- 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.



- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.03 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- 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. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
  - 3. PVC Piping: Join according to ASTM D2855 and ASTM D2665 Appendixes.

### 3.04 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, nonpressure transition couplings.

### 3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 23 05 29.
  - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  - 2. Install stainless-steel 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 (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
  - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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 12 inches (300 mm) 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 (10-mm) 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 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
  - 2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
  - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.

- F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
  - 2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
  - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
- H. Install supports for vertical PVC piping every 48 inches (1200 mm).
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### **3.06 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. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.
- 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 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### **3.07 IDENTIFICATION**

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 23 05 53.

### **3.08 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. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- 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 unconcealed 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 (30 kPa). 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 wg (250 Pa). 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.

### **3.09 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.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

### **3.10 PIPING SCHEDULE**

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller be any of the following:
  - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 2. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.Note: PVC not allowed in return air plenum.
- C. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
  - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.Note: PVC not allowed in return air plenum.
- D. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
  - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 2. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.

### **3.11 PAINTING**

- A. All sanitary waste and vent piping shall be painted upon completion of installation. Refer to Division 9 for color and type.

**END OF SECTION**

## SECTION 22 13 19

### SANITARY WASTE PIPING SPECIALTIES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Cleanouts.
  2. Floor drains.
  3. Trench drains.
  4. Roof flashing assemblies.
  5. Flashing materials.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

##### 1.05 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

#### PART 2 PRODUCTS

##### 2.01 CLEANOUTS

- A. Manufacturers:
  1. Watts.
  2. Zurn.
  3. Josam.
- B. Cleanouts at Interior Finished Floor Areas: Lacquered cast iron, two piece body with anchor flange, weep holes, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
- C. Cleanouts at Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
- D. Cleanouts at Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

## 2.02 FLOOR DRAINS

- A. Manufacturers:
  - 1. Zurn.
  - 2. Watts.
  - 3. Josam.
- B. Floor Drain (FD-1): Heavy duty lacquered cast iron body with bottom outlet, seepage pan, and adjustable extension frame with 9-inch diameter heavy duty cast iron deep flange slotted grate. Include sediment bucket. Acid resistant coating.
- C. Floor Drain (FD-2): Lacquered cast-iron two-piece body with double drainage flange, weep holes, reversible clamping collar, and round adjustable nickel bronze strainer.

## 2.03 TRENCH DRAINS

- A. Manufacturers:
  - 1. Zurn
  - 2. Polydrain
  - 3. Polycast
  - 4. Duratrench
- B. Trench Drain (TD-1): 12" wide, presloped, Fiber Reinforced Polymer (FRP) channels, radiused bottom, interlocking connections. Heavy duty reinforced, stainless steel slotted grate, Minimum DIN Class C. Trench drain frame load rating shall match rating of slotted grate (DIN Class C).

## 2.04 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
  - 1. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thick, lead flashing collar and skirt extending at least from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
  - 2. Open-Top Vent Cap: Without cap.
  - 3. Low-Silhouette Vent Cap: With vandal-proof vent cap.
  - 4. Extended Vent Cap: With field-installed, vandal-proof vent cap.

## 2.05 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. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
  - 2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
  - 3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## **PART 3 EXECUTION**

### **3.01 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 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) 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 (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) 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 air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- I. Install vent caps on each vent pipe passing through roof.
- J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

### **3.02 CONNECTIONS**

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### **3.03 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. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) 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 pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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 counterflashing or commercially made flashing fittings, according to Section 07 62 00 "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.

### **3.04 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 23 05 53.

### **3.05 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 30 00

### PLUMBING EQUIPMENT

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Inline Hot Water Recirculation Pumps
  2. Submersible Sump Pumps

##### 1.04 REFERENCE STANDARDS

- A. None

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  1. Include sizes, characteristics, accessories, trim, and finishes.
  2. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
  3. Indicate pump type, capacity, power requirements.
  4. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
  5. Provide electrical characteristics and connection requirements.

##### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

##### 1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

##### 1.08 CERTIFICATIONS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.



## PART 2 PRODUCTS

### 2.01 IN-LINE HOT WATER RECIRCULATION PUMPS

- A. Manufacturers
  - 1. Bell and Gossett
  - 2. Grundfos
  - 3. Taco
- B. Description: Factory-assembled and -tested, in-line, wet rotor circulation pump. Horizontal system lubricated type.
- C. Pump Construction: Lead free bronze or stainless steel construction suitable for potable water service.
- D. Capacities and Characteristics: Refer to equipment schedule.
- E. Accessories: Manufacturer's timer control kit.

### 2.02 DUPLEX SUBMERSIBLE GRINDER PUMPS AND SUMP

- 1. Manufacturers:
  - a. Zoeller Pump Company: [www.zoeller.com](http://www.zoeller.com).
  - b. Armstrong Pumps Inc.: [www.armstrongpumps.com](http://www.armstrongpumps.com).
  - c. Goulds Pumps: [www.goulds.com](http://www.goulds.com).
  - d. Weil Pump Company.
- 2. General: Pre-packaged, 36"x180" duplex basin system, pre-plumbed, with rail system, stainless steel lifting cables, lockable aluminum hatch cover with 2" vent, 2" discharge, lifting lugs, electrical coupling, check valves, and 4" inlet hub.
- 3. Grinder pumps
  - a. Materials:
    - 1) Housing: Cast iron
    - 2) Seals: Carbon/ceramic
    - 3) Impeller type: Vortex, engineered plastic
    - 4) Hardware: Stainless steel
    - 5) Motor shaft: Stainless steel
    - 6) Gasket & Square Ring: Neoprene
    - 7) Cutter: 440C stainless steel Rockwell C55-60
  - b. Capacity
    - 1) Max flow rate: 46 GPM
    - 2) Max Head: 107'
  - c. Motor
    - 1) Horsepower: 1.5
    - 2) Volts/Phase/Hz: 230V /1ph /60 Hz
    - 3) RPM: 3450
    - 4) Amps 10.8 amp
  - d. Control Panel
    - 1) Single phase duplex control panel
    - 2) 120V power
    - 3) NEMA 4X enclosure
    - 4) Circuit breaker
    - 5) Four (4) 20' normally open pipe clamp control float switches
  - e. Removal System
    - 1) Stainless steel rail system. Guide rails direct the pump to and from disconnect fitting.
    - 2) Disconnect fitting with positive machine fit and o-ring seal.
    - 3) System allows for removal of pumps from ground level.
  - f. Accessories
    - 1) Stainless steel lifting bail
    - 2) Float tree assembly

4. Control panel: UL listed and labeled, NEMA 4X motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electromechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Provide mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on (each pump), pump off (common), and alarm. System shall also include alarm output and running contact for input to plant SCADA system. The following shall be included on the panel door:
    - a. Through the door lockable panel disconnect with door interlock.
    - b. Pump 1 "On" light.
    - c. Pump 2 "On" light.
    - d. High water alarm light.
    - e. Control power light.
    - f. Pump 1 "test-off-auto" switch.
    - g. Pump 2 "test-off-auto" switch.
    - h. High water alarm horn.
    - i. Alarm horn silence button.
- B. Sump Basins
1. Type: Round, pre-engineered fiberglass sump basin. Basin shall be suitable for duplex pump system with top flange and round anti-float bottom collar.
  2. Internal dimensions: 36-inch diameter, 180-inch depth.
  3. Sump to include round, 3-inch heavy-duty fiberglass anti-flotation collar.
  4. Cover: Lockable Aluminum Hatch Cover with 2" vent.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Provide line sized ball valves on water heater inlet and outlet piping.
- C. Coordinate with plumbing piping to achieve operating system.
- D. The contractor shall align the pump and motor shafts to within the manufacturer's recommended tolerances prior to system start-up.
- E. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.
- F. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the controls contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.
- G. Pumps:
  1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

**END OF SECTION**

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## SECTION 22 34 00

### FUEL-FIRED, DOMESTIC-WATER HEATERS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  - 1. Gas-fired, tankless, domestic-water heaters.
  - 2. Domestic-water heater accessories.

##### 1.04 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.
- C. Product Certificates: For each type of gas-fired, tankless, domestic-water heater, from manufacturer.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Warranty: Sample of special warranty.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

##### 1.06 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: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

- C. ASME Compliance:
  - 1. 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.
  - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

## **1.07 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## **1.08 SPECIAL WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Gas-Fired, Tankless, Domestic-Water Heaters:
    - a. Heat Exchanger: Five years.
    - b. Controls and Other Components: Three years.

## **PART 2 PRODUCTS**

### **2.01 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS**

- A. Manufacturers:
  - 1. Navien
  - 2. AO Smith
  - 3. Rheem
  - 4. Engineer Approved Equivalent.
- B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.
- C. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
  - 1. Tappings: ASME B1.20.1 pipe thread.
  - 2. Pressure Rating: 150 psig (1035 kPa).
  - 3. Heat Exchanger: Copper tubing.
  - 4. Insulation: Comply with ASHRAE/IESNA 90.1.
  - 5. Jacket: Metal, with enameled finish.
  - 6. Burner: For use with tankless, domestic-water heaters and natural-gas fuel.
  - 7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
  - 8. Temperature Control: Adjustable thermostat.
- D. Support: Bracket for wall mounting.
- E. Separated combustion. CPVC air intake and exhaust piping. Size and termination shall be in accordance with manufacturer's guidelines.
- F. Capacity and Characteristics: Refer to equipment schedule.

### **2.02 DOMESTIC-WATER HEATER ACCESSORIES**

- A. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

- B. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 2-psig (13.8-kPa) pressure rating as required to match gas supply.
- C. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- D. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
  - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
  - 2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
- E. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.
- F. Built in freeze protection system for freeze protection to -20°F outdoor air temperature.

### **2.03 SOURCE QUALITY CONTROL**

- A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## **PART 3 EXECUTION**

### **3.01 DOMESTIC-WATER HEATER INSTALLATION**

- A. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters on wall bracket.
  - 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 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.
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
- D. Install pressure relief valves in water piping for domestic-water heaters without storage. 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.
- E. Install thermometer on outlet piping of domestic-water heaters.

### **3.02 CONNECTIONS**

- A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

- B. Comply with requirements for gas piping specified in Section 23 11 23 "Facility Natural-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

### **3.03 IDENTIFICATION**

- A. Identify system components. Comply with requirements for identification specified in 23 05 53.

### **3.04 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. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

### **3.05 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired, tankless domestic-water heaters.

**END OF SECTION**

## SECTION 23 05 00

### HVAC BASIC MATERIALS AND METHODS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. This Section specifies basic materials, methods, and workmanship requirements for the work described in Division 23.

##### 1.02 RELATED DOCUMENTS

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

##### 1.03 SUMMARY OF WORK

- A. The work to be accomplished under this specification, accompanying Division 23 specification sections, and the accompanying drawings, includes the furnishing of all labor, materials, equipment, and services necessary for the proper completion of all HVAC work under the Division 23 contract.
- B. The omission of express reference to any parts or services necessary for, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from furnishing such parts or services.
- C. The Division 23 Contractor shall be responsible for demolition and removal of all existing superfluous HVAC systems. No HVAC systems scheduled for demolition may be abandoned in place but rather shall be removed and disposed of off-site, unless specifically noted on the plans. Use of Owner's dumpsters for the disposition of any type of construction debris is not allowed.

##### 1.04 INSPECTION OF SITE

- A. Before submitting a proposal on the work outlined in this specification and accompanying drawings, each bidder shall examine the site and check as to the means of making connections to services and shall become familiar with all the existing conditions and limitations. No extras will be allowed because of the Contractor's misunderstanding as to the amount of work involved or his lack of knowledge of any site conditions that may affect his work. Any apparent variance of the plan or specification from the existing conditions at the site shall be called to the attention of the Engineer during the bid period so clarification can be made by addendum.
- B. It will be the responsibility of the Contractor to visit the site and make exact determination of the location of any wires, conduits, pipes, ducts, or other items prior to the submission of his bid. It is understood that they will be responsible for making the exact determination of the location and condition of such items.

##### 1.05 FEES, PERMITS, AND INSPECTIONS

- A. All required fees, permits, and inspections shall be obtained and/or arranged for by the Contractor under the section of the specifications for which they are required.
- B. Regular inspections shall be arranged by the Contractor as required by any and all regulations. All charges for inspections by regulating agencies of installations or review of plans and specifications shall be paid by the Contractor.



- C. Certificate of Final Inspection: Under each applicable section of the specifications, the Contractor shall, upon completion of the work under that section, furnish a Certificate of Final Inspection to the Engineer from the inspection department having jurisdiction.

## **1.06 CODES AND STANDARDS**

- A. All materials and workmanship shall comply with all applicable codes, specifications, ordinances, laws, regulations, industry standards, and utility company regulations.
- B. In case of difference between building codes, specifications, state laws, local ordinances, industry standards, and utility company regulations and the Contract Documents, the most stringent shall govern. The Contractor shall promptly notify the Engineer in writing of any such difference.
- C. Non-Compliance: Should the Contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards and utility company regulations, they shall bear all costs arising in correcting the deficiencies.

## **1.07 DRAWINGS**

- A. The drawings are to scale as noted but the Contractor shall refer to architectural and structural drawings for exact location of partitions, walls, beams, shafts, equipment, etc.
- B. Coordinate all work with building conditions and all trades.
- C. The project drawings show the general arrangement of work to be performed and shall be followed as closely as actual building construction and the work of other trades will permit.
- D. Dimensional information noted on Architectural and Structural drawings shall take precedence over Division 23 drawings.
- E. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required.
- F. The Division 23 contractor, before roughing in any facilities or installing any equipment, shall consult all drawings-general, landscape, structural, mechanical, electrical, kitchen or laboratory layout, etc.- and shall note any materials, finishes, locations of ceilings, structural members, pipes, ducts, recessed lighting fixtures, conduits, etc. which may affect the installation.
- G. The Division 23 contractor, in installing his equipment shall leave adequate room for the installation of equipment by other Contractors items where space is limited. The Contractor shall be cautioned that in certain instances, space may be limited to the extent that there may be only one arrangement of equipment or material which may be feasible.
- H. Discrepancies discovered before or after work has started, shall be brought to the attention of the Engineer immediately and the Engineer reserves the right to require minor changes in the work of any Contractor to eliminate such discrepancies with no change in contract cost.
- I. The plans and specifications are complementary and what is called for in either one shall be as binding as if called for in both.
- J. Where a disagreement exists between the plans and specifications, the item or arrangement of better quality, greater quantity, or higher cost, shall be included in the bid.

## **1.08 SYMBOLS AND ABBREVIATIONS**

- A. Refer to symbols and abbreviations on drawings. Other symbols are in common usage but if uncertainty exists regarding any plan symbols or abbreviations it shall be brought to the attention of the Engineer.

- B. Within the contract documents, the word "Provide" shall be considered to be equivalent to the phrase "Furnish and Install".

### **1.09 CUTTING AND PATCHING**

- A. Each contractor shall be responsible for providing and coordinating cutting and patching as may be required for items to be provided under their contract. See Section 01 73 00 Execution.
- B. Each contractor shall perform all cutting and patching necessary in order to perform their work unless such work has been delegated to the General Contractor. However, special permission shall be obtained from the Engineer before cutting structural members or finished material. All patching shall be performed in such manner as to leave no visible trace and to return the part affected to the condition of undisturbed work. Patching work shall be performed by persons experienced, skilled and licensed for the particular type of work involved. Inferior work will not be accepted. Pipe penetrations through new or existing floors and walls, regardless of type of construction, shall be done by rotary drill, wet or dry method. Use of hand, electric, or pneumatic impact tool is not acceptable. Each contractor shall contain water and dust to avoid damage to adjacent finishes, furniture and equipment.
- C. Each contractor may need to provide additional selective demolition not shown on the drawings as required for installation of new building elements and systems.
- D. Pavements, sidewalks, roads and curbs shall be cut, patched, repaired and replaced as required to permit the installation of the work of each trade. Such cutting, patching, repairing and replacing shall be the responsibility of and paid for by the trade requiring the work.
- E. Each contractor shall bear the expense of all cutting, patching, repairing, or replacing of the work of other trades required because of their fault, error, tardiness, or damage done.

### **1.10 HOLES THROUGH MASONRY AND CONCRETE**

- A. Each trade shall provide all holes and openings required for his work unless such holes and openings are shown to be provided on the architectural or structural drawings. Pay particular attention to openings required in pre-cast, pre-stressed, or post-tensioned slabs.
- B. Holes made in the field shall be core drilled large enough to allow all pipe insulation to continue uninterrupted. Holes in floors or exterior walls above grade shall include a steel pipe sleeve grouted watertight.
- C. The above method shall be employed whenever holes are made on the job including holes required by change orders or because of omissions made inadvertently by the trade.
- D. Pipe openings in exterior walls below grade between earth areas and interior spaces shall include a steel pipe sleeve and a mechanical seal.
- E. Each trade shall be responsible for providing and disposing of water they use in the core drilling operation. Such work shall be scheduled and other trades coordinated so that damage will not result from the use of water.

### **1.11 PAINTING**

- A. Painting shall comply with the requirements of Division 09.
- B. Refer to the General Construction Specifications for Painting and report any discrepancies to the Architect/Engineer for clarification by addendum.
- C. Pre-painted equipment delivered to the job-site prime-painted or finish-painted shall be touched up as necessary and/or as directed. When available, spray cans of the paint shall be obtained from the equipment manufacturer.

### **1.12 ACCESS PANELS IN WALLS AND CEILING**

- A. Division 23 shall be responsible to provide all access panels, not otherwise provided by Division 1, which are necessary to provide required access to items provided under the Division 23 contract.
- B. Access panels shall be as manufactured by Milcor or approved equal and of type that is compatible with construction and finish of the wall and/or ceiling.
- C. Fire rated panels shall be furnished where required in rated construction.
- D. Access panels shall be provided at the following locations:
  - 1. Access shall be provided to any type of valve, trap, manual vent, and control valve that requires adjustment, replacement, or visual inspection.
  - 2. Division 23 shall consult with the General Contractor to coordinate the location of each access panel.
  - 3. Generally, access panels are not required when a lay-in-ceiling is installed. However, depending on the type of occupancy, the Engineer may require that access areas be identified.

### **1.13 CONTINUITY OF SERVICES**

- A. The building will be in use during these operations. The Division 23 contractor shall schedule his work, in consultation with other trades, and carry it out in such a manner as to least inconvenience the occupants due to interruption of mechanical services.
- B. Interruptions shall be confined to the smallest area possible at any one time and all interruptions shall be approved by the Owner. Temporary connections shall be made if required to provide continuity of service.
- C. After service has been restored following an interruption, each trade shall inspect all areas affected by the interruptions and be responsible for returning all services to the same operating condition which existed prior to the interruption.

### **1.14 USE OF FACILITY**

- A. The normal use of the facility shall not be disturbed, except within the immediate construction area. All walks, driveways and entrances shall be kept clear and free of all Contractor's equipment, material and debris at all times.

### **1.15 PREFABRICATION**

- A. If a Contractor elects to prefabricate items to be provided under their contract, the Contractor is still obligated to abide by all requirements for cooperation with other trades and shall not assume that their material will be installed first and other trades must follow.
- B. If changes are made by the Architect/Engineer reasonably in advance of anticipated installation, the Owner shall not be penalized with added cost because materials were prefabricated in advance.

### **1.16 CLEANUP**

- A. Each trade shall periodically clear away all debris, surplus materials, etc. resulting from his work or operations, leaving the job and the equipment furnished under any or all contracts in a clean condition.

### **1.17 INSTRUCTION OF OPERATING PERSONNEL**

- A. Each trade shall furnish, without additional expense to the Owner, the services of competent instructors, who will give full instruction in the care, adjustment, and operation and maintenance of all parts of the equipment to the Owner's permanent employees who are to have charge of the equipment.

- B. Each instructor shall be thoroughly familiar with all parts of the installation on which they are to give instructions and shall be trained in operating theory as well as in practical operation and maintenance work. Factory trained instructors shall be employed wherever they are available. Instruction shall be given during regular workweek and at a time just prior to the time the equipment is accepted and turned over to the Owner for regular operation.

#### **1.18 MAINTENANCE AND OPERATING MANUALS**

- A. The Contractor shall prepare 3 ring binders. Each binder shall contain material and equipment data sheets, installation details, instructions, and schematics of actual equipment and operations directions supplied by the manufacturer for each item of equipment. Final acceptance of the work will be withheld until such data has been presented complete to the Engineer for transmission to the Owner. The manual shall be available for instruction of operations and maintenance of equipment and systems.
- B. The number of manuals shall be as stated in the Special Conditions with a minimum of three (3).

#### **1.19 TESTS**

- A. Each trade shall test the equipment provided and/or installed under this specification and shall demonstrate its proper operation to the Owner's operating engineer and trade shops.
- B. No equipment shall be tested or operated for any purpose until it has been fully prepared, lubricated and properly connected and made ready for normal operation. Any damage to equipment occasioned by improper or ill-timed operation or testing shall be made good at the Contractor's own expense, before final inspection and acceptance.

#### **1.20 DRAIN LINES FROM EQUIPMENT**

- A. Unless noted otherwise, noted, each item of equipment requiring a drain line or a conductor for liquid shall be provided an "open site" drain, such as a standpipe, floor drain, or a janitors sink. Direct connection to existing or new waste and vent stacks or rainwater leaders is not acceptable.
- B. Condensate and indirect drain piping in finished spaces shall be copper, painted with aluminum paint. Provide a loop in the piping to provide gas seal.
- C. Division 23 shall also provide drains on items of equipment as noted in Miscellaneous Work.

#### **1.21 SHOP DRAWINGS**

- A. The quantity of shop drawings to be submitted shall be as noted in the General Conditions.

#### **1.22 DEMOLITION**

- A. The demolition work shall be a phased operation and shall comply with the construction sequence schedule. Coordinate with Owner.
- B. The Division 23 Contractor shall include all temporary connections necessary to permit the Owner to occupy areas of the building during the various construction phases.
- C. The Division 23 Contractor shall be responsible for coordinating the mechanical installations to prevent disruption to the Owner and minimize the "downtime." The Architect/Owner's approval shall be sought prior to all cut-off of services.
- D. The Division 23 Contractor shall remove existing work shown, specified or necessary for completion of his work. Owner shall have the option of the retaining any or all items of material removed under this contract. Items or materials not retained by Owner shall become the property of the Contractor and shall be removed from the premises.

- E. The Division 23 Contractor shall verify the extent of the remodeling work and any details not clear to this Contractor shall be referred to the Architect/Engineer for clarification prior to commencing demolition work.
- F. The revised installation within the remodeled areas shall be concealed unless noted otherwise. All surface work shall be verified with the Architect.

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

Not Used

**END OF SECTION**

## SECTION 23 05 13

### COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 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.

##### 1.04 COORDINATION

- A. Coordinate features of motors, 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.

#### PART 2 PRODUCTS

##### 2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

##### 2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 degrees C and at altitude of 3300 feet (1000 m) 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.

##### 2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  1. For motors with 2:1 speed ratio, consequent pole, single winding.

- 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

#### **2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS**

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

#### **2.05 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: Variable-torque, 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 Used

**END OF SECTION**

## SECTION 23 05 29

### HANGERS & SUPPORTS FOR HVAC & PLUMBING PIPING & EQUIPMENT

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Metal pipe hangers and supports.
  2. Trapeze pipe hangers.
  3. Thermal-hanger shield inserts.
  4. Fastener systems.
  5. Equipment supports.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

##### 1.06 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

##### 2.01 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: Pregalvanized 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 stainless steel.
- 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.
  3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- 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 stainless steel.

## **2.02 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.

## **2.03 THERMAL-HANGER SHIELD INSERTS**

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig (688-kPa) or minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## **2.04 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.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## **2.05 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## **2.06 MISCELLANEOUS MATERIALS**

- A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## PART 3 EXECUTION

### 3.01 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 A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. 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.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. 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 (DN 65) 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.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. 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.
- L. 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 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### **3.02 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.

### **3.03 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.

### **3.04 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 (40 mm).

### **3.05 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 (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

### **3.06 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 trapeze pipe hangers 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 or stainless-steel 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 degrees F (566 degrees C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100mm) of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- 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 (DN 24 to DN 600).
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) 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 (150 mm) for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 degrees F (49 to 232 degrees C) 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. 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 (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 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. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

**END OF SECTION**

## SECTION 23 05 48.13

### VIBRATION CONTROLS FOR HVAC

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Elastomeric isolation pads.
  2. Elastomeric isolation mounts.
  3. Restrained elastomeric isolation mounts.
  4. Housed-spring isolators.
  5. Restrained-spring isolators.
  6. Housed-restrained-spring isolators.
  7. Pipe-riser resilient supports.
  8. Resilient pipe guides.
  9. Elastomeric hangers.
  10. Spring hangers.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### PART 2 PRODUCTS

##### 2.01 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
  1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  2. Size: Factory or field cut to match requirements of supported equipment.
  3. Pad Material: Oil and water resistant with elastomeric properties.
  4. Surface Pattern: Ribbed pattern.
  5. Infused nonwoven cotton or synthetic fibers.
  6. Load-bearing metal plates adhered to pads.

##### 2.02 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
  1. Mounting Plates:
    - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
  2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.03 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Restrained Elastomeric Isolation Mounts:
  - 1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    - a. Housing: Cast-ductile iron or welded steel.
    - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.04 HOUSED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
  - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
    - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    - b. Top housing with attachment and leveling bolt.

## 2.05 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
  - 1. Housing: Steel housing with vertical limit stops to prevent spring extension due to weight being removed.
    - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    - b. Top plate with threaded mounting holes.
    - c. Internal leveling bolt that acts as blocking during installation.
  - 2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
  - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.06 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
  - 1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
    - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
  - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.07 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch (13-mm) thick neoprene.
  - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  - 2. Maximum Load Per Support: 500 psig (3.45 MPa) on isolation material providing equal isolation in all directions.

## 2.08 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch (13-mm) thick neoprene.
  - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.09 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
  - 1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
  - 2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.10 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
  - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  - 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

## PART 3 EXECUTION

### 3.01 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 3
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

**END OF SECTION**



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## SECTION 23 05 53

### IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Equipment labels.
  2. Warning signs and labels.
  3. Pipe labels.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### PART 2 PRODUCTS

##### 2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  1. Material and Thickness: stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Letter Color: Black.
  3. Background Color: White.
  4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch (64 by 19 mm).
  5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  6. Fasteners: Stainless-steel rivets or self-tapping screws.
  7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
  1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
  2. Letter Color: Black.
  3. Background Color: White.
  4. Maximum Temperature: Able to withstand temperatures up to 160 degrees F (71 degrees C).
  5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch (64 by 19 mm).
  6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and

- proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
  8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-inch by 11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## **2.02 WARNING SIGNS AND LABELS**

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Red.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 degrees F (71 degrees C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters 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.

## **2.03 PIPE LABELS**

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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: Size letters according to ASME A13.1 for piping.

## **PART 3 EXECUTION**

### **3.01 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.

### **3.02 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### **3.03 PIPE LABEL INSTALLATION**

- A. Piping Color-Coding: Painting of piping is specified in Division 9.
- B. Pipe Label Locations: 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 and on both sides of 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 (15 m) along each run. Reduce intervals to in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
  - 1. Domestic Water Piping
    - a. Background: Safety green.
    - b. Letter Colors: White.
  - 2. Sanitary Waste and Storm Drainage Piping:
    - a. Background Color: Safety black.
    - b. Letter Color: White.

**END OF SECTION**

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## SECTION 23 05 93

### TESTING, ADJUSTING, AND BALANCING FOR HVAC

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.

##### 1.02 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

##### 1.03 INFORMATIONAL SUBMITTALS

- A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.

##### 1.04 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC NEBB or TABB.
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC NEBB or TABB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

#### PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.01 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 installed systems for 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 applicable for intended purpose and 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 underfloor air plenums used for supply, return, or relief air to verify that they 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 verify that bearings are greased, belts are aligned and tight, filters are clean, 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 have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, 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.

### **3.02 PREPARATION**

- A. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:
    - a. Duct systems are complete with terminals installed.
    - b. Volume, smoke, and fire dampers are open and functional.
    - c. Clean filters are installed.
    - d. Fans are operating, free of vibration, and rotating in correct direction.
    - e. Variable-frequency controllers' startup is complete and safeties are verified.
    - f. Automatic temperature-control systems are operational.
    - g. Ceilings are installed.
    - h. Windows and doors are installed.
    - i. Suitable access to balancing devices and equipment is provided.

### **3.03 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" and in this Section.
- 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.
  - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation".
- 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.

### **3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS**

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- C. 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.
- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections and functioning.
- I. Check for proper sealing of air-handling-unit components.



J. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

### 3.05 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:
    - 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 artificial loading of filters at the time static pressures are measured.
  3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  4. 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.
  5. 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 occurs. 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.
1. Measure airflow of submain and branch ducts.
  2. Adjust submain and branch duct volume dampers for specified airflow.
  3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  2. Measure inlets and outlets airflow.
  3. Adjust each inlet and outlet for specified airflow.
  4. Re-measure each inlet and outlet after they have been adjusted.

### 3.06 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.07 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 specialist.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  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. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Fuel type in input data.
    - g. Output capacity in Btu/h (kW).
    - h. Ignition type.
    - i. Burner-control types.
    - j. Motor horsepower and rpm.
    - k. Motor volts, phase, and hertz.
    - l. Motor full-load amperage and service factor.
    - m. Sheave make, size in inches (mm), and bore.
    - n. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
  2. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm (L/s).
    - b. Entering-air temperature in deg. F (deg. C).
    - c. Leaving-air temperature in deg. F (deg. C).
    - d. Air temperature differential in deg. F (deg. C).

- e. Entering-air static pressure in inches wg (Pa).
  - f. Leaving-air static pressure in inches wg (Pa).
  - g. Air static-pressure differential in inches wg (Pa).
  - h. Low-fire fuel input in Btu/h (kW).
  - i. High-fire fuel input in Btu/h (kW).
  - j. Manifold pressure in psig (kPa).
  - k. High-temperature-limit setting in deg. F (deg. C).
  - l. Operating set point in Btu/h (kW).
  - m. Motor voltage at each connection.
  - n. Motor amperage for each phase.
  - o. Heating value of fuel in Btu/h (kW).
- E. 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 (mm), and bore.
    - h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
  - 2. Motor Data:
    - a. Motor 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 (mm), and bore.
    - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
    - g. Number, make, and size of belts.
  - 3. Test Data (Indicated and Actual Values):
  - 4. Total airflow rate in cfm (L/s).
  - 5. Total system static pressure in inches wg (Pa).
  - 6. Fan rpm.
  - 7. Discharge static pressure in inches wg (Pa).
  - 8. Suction static pressure in inches wg (Pa).
- F. 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 deg. F (deg. C).
    - d. Duct static pressure in inches wg (Pa).
    - e. Duct size in inches (mm).
    - f. Duct area in sq. ft. (sq. m).
    - g. Indicated airflow rate in cfm (L/s).
    - h. Indicated velocity in fpm (m/s).
    - i. Actual airflow rate in cfm (L/s).
    - j. Actual average velocity in fpm (m/s).
    - k. Barometric pressure in psig (Pa).
- G. Air-Terminal-Device Reports:
- 1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.

- f. Number from system diagram.
  - g. Type and model number.
  - h. Size.
  - i. Effective area in sq. ft. (sq. m).
2. Test Data (Indicated and Actual Values):
- a. Airflow rate in cfm (L/s).
  - b. Air velocity in fpm (m/s).
  - c. Preliminary airflow rate as needed in cfm (L/s).
  - d. Preliminary velocity as needed in fpm (m/s).
  - e. Final airflow rate in cfm (L/s).
  - f. Final velocity in fpm (m/s).
  - g. Space temperature in deg. F (deg. C).
- H. 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 number and serial number.
  - f. Water flow rate in gpm (L/s).
  - g. Water pressure differential in feet of head or psig (kPa).
  - h. Required net positive suction head in feet of head or psig (kPa).
  - i. Pump rpm.
  - j. Impeller diameter in inches (mm).
  - 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 (kPa).
  - b. Pump shutoff pressure in feet of head or psig (kPa).
  - c. Actual impeller size in inches (mm).
  - d. Full-open flow rate in gpm (L/s).
  - e. Full-open pressure in feet of head or psig (kPa).
  - f. Final discharge pressure in feet of head or psig (kPa).
  - g. Final suction pressure in feet of head or psig (kPa).
  - h. Final total pressure in feet of head or psig (kPa).
  - i. Final water flow rate in gpm (L/s).
  - j. Voltage at each connection.
  - k. Amperage for each phase.
- I. Instrument Calibration Reports:
1. Report Data:
- a. Instrument type and make.
  - b. Serial number.
  - c. Application.
  - d. Dates of use.
  - e. Dates of calibration.

### 3.08 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.

- B. Architect 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.
- C. 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."
- D. 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.
- E. If TAB work fails, proceed as follows:
  - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
  - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
  - 3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

**3.09 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

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section includes insulating the following duct services:
  1. Indoor, exposed supply and outdoor air.
  2. Indoor, exposed return located in unconditioned space.
  3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
  3. Detail application of field-applied jackets.
  4. Detail application at linkages of control devices.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.06 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, 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.

## **PART 2 PRODUCTS**

### **2.01 INSULATION MATERIALS**

- A. Manufacturers:
  - 1. Knauf.
  - 2. Johns Manville.
  - 3. Owens Corning.
  - 4. Certainteed.
- B. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

### **2.02 FIRE-RATED INSULATION SYSTEMS**

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

### **2.03 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. 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).
  - 2. 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. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. 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. 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."

## 2.04 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. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 degrees F (Minus 29 to plus 82 degrees C).
  - 3. Solids Content: ASTM D1644, 58 percent by volume and 70 percent by weight.
  - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 degrees F (Minus 29 to plus 82 degrees C).
  - 3. Solids Content: 60 percent by volume and 66 percent by weight.
  - 4. Color: White.

## 2.05 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 degrees F (Minus 40 to plus 121 degrees C).
  - 4. Color: Aluminum.
  - 5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 6. 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."

## 2.06 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 C1136, Type II.

## 2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

## 2.08 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
  - 1. Width: 3 inches (75 mm).
  - 2. Thickness: 6.5 mils (0.16 mm).
  - 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.



## 2.09 SECUREMENTS

- A. Aluminum Bands: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
  - 1. Metal, Adhesively Attached, Perforated-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. Comply with the following requirements:
    - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch (0.76 mm) thick by 2 inches (50 mm) square.
    - b. Spindle: Aluminum, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  - 2. 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. Comply with the following requirements:
    - a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
    - b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
    - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  - 3. 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. Comply with the following requirements:
    - a. Baseplate: Galvanized carbon-steel sheet, 0.030-inch (0.76 mm) thick by 2 inches (50 mm) square.
    - b. Spindle: Aluminum, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    - c. Adhesive-backed base with a peel-off protective cover.
  - 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  - 5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41 mm) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.02 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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) 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 (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### **3.03 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 (50 mm) 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 (50 mm).
  - 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 (50 mm).
  - 1. Comply with requirements in Division 7.
- 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 (50 mm).
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7.

### 3.04 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 100 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 (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) 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 overcompress 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 (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25 mm) 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 degrees F (10 degrees C) at 18-foot (5.5-m) 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 (75 mm).
  - 5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) 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 (150-mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) 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 100 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 (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) 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 overcompress 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 (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25-mm) 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 degrees F (10 degrees C) at 18-foot (5.5-m) 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 (75 mm).
  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 (150-mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

### 3.05 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 (38-mm) laps at longitudinal seams and 3-inch (75-mm) wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

### 3.06 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

- B. Insulate duct access panels and doors to achieve same fire rating as duct.
  - 1. Install firestopping at penetrations through fire-rated assemblies.

### **3.07 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect ductwork, 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 one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### **3.08 DUCT INSULATION SCHEDULE, GENERAL**

- A. Plenums and Ducts Requiring Insulation:
  - 1. Indoor, concealed supply, return, and outdoor air.
  - 2. Indoor, exposed supply, return, and outdoor air.
  - 3. Indoor, concealed exhaust within 6' of building exterior.
  - 4. Indoor, exposed exhaust within 6' of building exterior.
- B. Items Not Insulated:
  - 1. Fibrous-glass ducts.
  - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  - 3. Factory-insulated flexible ducts.
  - 4. Factory-insulated plenums and casings.
  - 5. Flexible connectors.
  - 6. Vibration-control devices.
  - 7. Factory-insulated access panels and doors.

### **3.09 INDOOR DUCT AND PLENUM INSULATION SCHEDULE**

- A. Exposed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber board, 1-1/2 inches (38 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.
- B. Exposed, Exhaust-Air Duct and Plenum Insulation (within 10' of building exterior): Mineral-fiber board, 1-1/2 inches (38 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.

**END OF SECTION**

## SECTION 23 09 93

### HVAC CONTROLS AND SEQUENCE OF OPERATION

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Related Requirements:
  - 1. All control and power wiring shall be in conduit in accordance with Division 26. Refer to Division 26 specifications for additional information.

##### 1.04 DEFINITIONS

- A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).
- B. Binary Output: On/off output signal or contact closure.
- C. DDC: Direct digital control.
- D. Digital Output: Data output that must be interpreted digitally.

##### 1.05 ACTION SUBMITTALS

- A. Product Data:
  - 1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
  - 2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.
  - 3. Control System Diagrams: Submit graphic schematic of the control systems showing each control component and each component controlled, monitored, or enabled.
    - a. Label with settings, adjustable range of control, and limits.
    - b. Include written description of control sequences.
    - c. Include flow diagrams for each control system, graphically depicting control logic.

##### 1.06 CONTROL SYSTEM

- A. Control systems shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, connected to controllers programmed to control mechanical systems.

- B. All control systems are stand-alone type systems utilizing unitary controllers, PLC controllers, touch screen controllers etc. There are no building automation systems in any of the facilities.

## 1.07 CONTROL EQUIPMENT

### A. Unitary Controllers

1. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
  - a. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
  - b. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostic; monitor system and report results.
  - c. Enclosure: Dustproof rated for operation at 32 to 120 degrees F.

### B. Electronic Sensors

1. Description: Vibration and corrosion resistant for wall, immersion, or duct mounting as required.
2. Thermistor Temperature Sensors and Transmitters:
  - a. Accuracy: Plus or minus 0.5 degree F at calibration point.
  - b. Wire: Twisted, shielded pair cable.
  - c. Insertion Elements in Ducts: Single point, 8 inches long, use where not affected by temperature stratification or where ducts are smaller than 9 square feet.
  - d. Averaging elements in ducts: 36 inches long, flexible 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 10 square feet.
  - e. Room Sensor Cover construction: Manufacturer's standard locking covers.
  - f. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

### C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted shielded pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long, use where not affected by temperature stratification or where ducts are smaller than 9 square feet.
4. Averaging elements in ducts: 36 inches long, flexible 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 10 square feet.
5. Digital Room Temperature Sensors: Digital LCD display with setpoint and actual temperature indication.

### D. Humidity Sensors: Bulk polymer sensor element:

1. Accuracy: 5 percent full range with linear input.
2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
4. Outside Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure suitable for operation at outdoor air temperatures from 32 to 120 degrees F.

### E. Status Sensors:

1. Status input for fans: Differential pressure switch with pilot duty rating and with adjustable range of 0-5-inch wg.
2. Status Input for Electric Motors: Comply with ISA 50.001, current sensing fixed or split core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
3. Voltage Transmitter (100-600 V-ac): Comply with ISA 50.001, single loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
4. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4-20 ma KW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
5. Current Switches: Self-powered, solid state with adjustable trip current, selected to match current and system output requirements.

- 6. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2-10 Vdc feedback signal.
- F. Actuators: Refer to Specification Section 23 33 00 air duct accessories - "damper operators".
- G. Dampers: Refer to Specification Section 23 33 00 air duct accessories - "automatic control dampers".
- H. Electrical Wiring and Connections: Install all power and control wiring in conduit in accordance with the requirements of Division 26.

## **1.08 CONTROL SEQUENCES**

- A. Ventilation Sequences:
  - 1. Toilet Room 102: Space is served by exhaust fan EF-4. Fan shall be interlocked with light switch by division 26.
  - 2. Chlorine Room 103: Space served by exhaust fan EF-1 and intake louver with motorized damper MD-1. System shall be controlled with wall mounted fan switch at exterior door and at observation window. Upon activation, MD-1 shall open fully and EF-1 shall be commanded on and shall ventilate the space at a rate of 60 air changes per hour. Refer to Division 26 control schematic.
  - 3. Chemical Room 104: Space served by exhaust fan EF-2 and intake louver with motorized damper MD-2. EF-2 shall be interlocked with the light switch by Division 26. When light is on, EF-2 shall be active and motorized damper shall be open.
  - 4. Fluoride Room 105: Space served by exhaust fan EF-3 and intake louver with motorized damper MD-3. EF-3 shall be interlocked with the light switch by Division 26. When light is on, EF-3 shall be active and motorized damper shall be open.
- B. Gas Fired Unit Heaters: Control via wall mounted thermostat provided by unit heater manufacturer.
- C. Electric Unit Heaters: Control via wall mounted thermostat provided by unit heater manufacturer.
- D. Electric Wall Heaters: Control via unit mounted thermostat provided by unit heater manufacturer.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

Not Used

**END OF SECTION**



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## SECTION 23 11 23

### FACILITY NATURAL-GAS PIPING

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 RELATED DOCUMENTS

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

##### 1.04 SUMMARY

- A. Section Includes:
  1. Pipes, tubes, and fittings.
  2. Piping specialties.
  3. Piping and tubing joining materials.
  4. Valves.
  5. Pressure regulators.

##### 1.05 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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.

##### 1.06 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
  1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).

##### 1.07 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  1. Piping specialties.
  2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  3. Pressure regulators. Indicate pressure ratings and capacities.

- 4. Dielectric fittings.

## **1.08 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For motorized gas valves pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

## **1.09 QUALITY ASSURANCE**

- A. Steel Support 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.
- 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.

## **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. 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.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

## **1.11 PROJECT CONDITIONS**

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

## **PART 2 PRODUCTS**

### **2.01 PIPES, TUBES, AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - a. Material Group: 1.1.
    - b. End Connections: Threaded or butt welding to match pipe.
    - c. Lapped Face: Not permitted underground.
    - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
    - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
  - 5. Mechanical Couplings:
    - a. Steel flanges and tube with epoxy finish.
    - b. Buna-nitrile seals.
    - c. Stainless-steel bolts, washers, and nuts.

- d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
- e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

## 2.02 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 degrees F (540 degrees C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

## 2.03 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig (862 kPa).
  - 2. Threaded Ends: Comply with ASME B1.20.1.
  - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
  - 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
  - 1. CWP Rating: 125 psig (862 kPa).
  - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
  - 1. Body: Bronze, complying with ASTM B 584.
  - 2. Ball: Chrome-plated brass.
  - 3. Stem: Bronze; blowout proof.
  - 4. Seats: Reinforced TFE; blowout proof.
  - 5. Packing: Separate packnut with adjustable-stem packing threaded ends.
  - 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 7. CWP Rating: 600 psig (4140 kPa).
  - 8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
  - 1. Body: Bronze, complying with ASTM B 584.
  - 2. Ball: Chrome-plated bronze.
  - 3. Stem: Bronze; blowout proof.
  - 4. Seats: Reinforced TFE; blowout proof.
  - 5. Packing: Threaded-body packnut design with adjustable-stem packing.
  - 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
  2. Plug: Bronze.
  3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  4. Operator: Square head or lug type with tamperproof feature where indicated.
  5. Pressure Class: 125 psig (862 kPa).
  6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
  2. Plug: Bronze or nickel-plated cast iron.
  3. Seat: Coated with thermoplastic.
  4. Stem Seal: Compatible with natural gas.
  5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  6. Operator: Square head or lug type with tamperproof feature where indicated.
  7. Pressure Class: 125 psig (862 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
  2. Plug: Bronze or nickel-plated cast iron.
  3. Seat: Coated with thermoplastic.
  4. Stem Seal: Compatible with natural gas.
  5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  6. Operator: Square head or lug type with tamperproof feature where indicated.
  7. Pressure Class: 125 psig (862 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

## 2.04 MOTORIZED GAS VALVES

- A. Automatic Gas Valves: Comply with ANSI Z21.21.
1. Body: Brass or aluminum.
  2. Seats and Disc: Nitrile rubber.
  3. Springs and Valve Trim: Stainless steel.
  4. Normally closed.
  5. Visual position indicator.
  6. Electrical operator for actuation by appliance automatic shutoff device.
- B. Electrically Operated Valves: Comply with UL 429.
1. Pilot operated.
  2. Body: Brass or aluminum.
  3. Seats and Disc: Nitrile rubber.
  4. Springs and Valve Trim: Stainless steel.
  5. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
  6. NEMA ICS 6, Type 4, coil enclosure.

7. Normally closed.
8. Visual position indicator.

## 2.05 PRESSURE REGULATORS

- A. General Requirements:
  1. Single stage and suitable for natural gas.
  2. Steel jacket and corrosion-resistant components.
  3. Elevation compensator.
  4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
  1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
  2. Springs: Zinc-plated steel; interchangeable.
  3. Diaphragm Plate: Zinc-plated steel.
  4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
  5. Orifice: Aluminum; interchangeable.
  6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
  8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
  9. Overpressure Protection Device: Factory mounted on pressure regulator.
  10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
  11. Maximum Inlet Pressure: 2 psig (13.8 kPa).
- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
  1. Body and Diaphragm Case: Die-cast aluminum.
  2. Springs: Zinc-plated steel; interchangeable.
  3. Diaphragm Plate: Zinc-plated steel.
  4. Seat Disc: Nitrile rubber.
  5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
  7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
  8. Maximum Inlet Pressure: 2 psig (13.8 kPa).

## 2.06 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.
- B. Dielectric Unions:
  1. Description:
  2. Standard: ASSE 1079.
  3. Pressure Rating: 125 psig (860 kPa) minimum at 180 degrees F (82 degrees C).
  4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  1. Description:
    - a. Standard: ASSE 1079.
    - b. Factory-fabricated, bolted, companion-flange assembly.
    - c. Pressure Rating: 125 psig (860 kPa) minimum at 180 degrees F (82 degrees C).
    - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

- D. Dielectric-Flange Insulating Kits:
  - 1. Description:
    - a. Nonconducting materials for field assembly of companion flanges.
    - b. Pressure Rating: 150 psig (1035 kPa).
    - c. Gasket: Neoprene or phenolic.
    - d. Bolt Sleeves: Phenolic or polyethylene.
    - e. Washers: Phenolic with steel backing washers.

## **2.07 LABELING AND IDENTIFYING**

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

### **3.03 OUTDOOR PIPING INSTALLATION**

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
  - 3. Replace pipe having damaged PE coating with new pipe.
- C. Copper Tubing with Protective Coating:
  - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- D. Install fittings for changes in direction and branch connections.
- E. Install pressure gage upstream and downstream from each service regulator.

### **3.04 INDOOR PIPING INSTALLATION**

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
  - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
  - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
  - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
  - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    - a. Exception: Tubing passing through partitions or walls does not require striker barriers.



- 5. Prohibited Locations:
  - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
  - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors.
- X. Install sleeve seals for piping penetrations of concrete walls and slabs.
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- Z. Extend natural gas piping to all-natural gas fired equipment. Provide shut off valve, regulator, and drip leg at all-natural gas fired equipment.

### **3.05 VALVE INSTALLATION**

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

### **3.06 PIPING JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  - 2. Cut threads full and clean using sharp dies.
  - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
  - 5. 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. Welded Joints:
  - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.
  3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. 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.

### 3.07 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
  2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
  3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
  4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
  5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).

### 3.08 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### 3.09 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

### **3.10 PAINTING**

- A. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Alkyd System: MPI EXT 5.1D.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    - c. Topcoat: Exterior alkyd enamel (gloss).
    - d. Color: Grey
- B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Interior latex matching topcoat.
    - c. Topcoat: Interior latex (gloss).
    - d. Color: Gray.
  - 2. Alkyd System: MPI INT 5.1E.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Interior alkyd matching topcoat.
    - c. Topcoat: Interior alkyd (gloss).
    - d. Color: Red.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

### **3.11 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.12 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

### **3.13 OUTDOOR PIPING SCHEDULE**

- A. Aboveground natural-gas piping shall be the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints. All outdoor piping shall be painted in accordance with 3.10.

### **3.14 INDOOR PIPING SCHEDULE**

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints. All exposed piping shall be painted. Refer to Paragraph 3.10.

- B. Aboveground, distribution piping shall be the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints. All exposed piping shall be painted. Refer to paragraph 3.10.

### **3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
  - 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
- D. Valves in branch piping for single appliance shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.

**END OF SECTION**

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## SECTION 23 31 13

### METAL DUCTS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  - 1. Rectangular ducts and fittings.
  - 2. Round ducts and fittings.
  - 3. Sheet metal materials.
  - 4. Sealants and gaskets.
  - 5. Hangers and supports.
- B. Related Sections:
  - 1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
  - 2. Section 23 31 16 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
  - 3. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

##### 1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

## **PART 2 PRODUCTS**

### **2.01 RECTANGULAR DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### **2.02 ROUND DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Fabricate round ducts larger Than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### **2.03 SHEET METAL MATERIALS**

- A. General Material Requirements: 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.

- B. Galvanized Sheet Steel: Comply with ASTM A653/A 653M.
  - 1. Galvanized Coating Designation: G90 (Z275).
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

## 2.04 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
  - 1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 2. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
    - a. 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).
    - b. 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."
- B. Insulation Pins and Washers:
  - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
  - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick aluminum; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
  - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  - 3. Butt transverse joints without gaps, and coat joint with adhesive.
  - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  - 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).
  - 7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.



8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
  - a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.05 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
  1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  2. Tape Width: 3 inches (76 mm).
  3. Sealant: Modified styrene acrylic.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
  7. Service: Indoor and outdoor.
  8. Service Temperature: Minus 40 to plus 200 degrees F (Minus 40 to plus 93 degrees C).
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
  10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  11. Sealant 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. Water-Based Joint and Seam Sealant:
  1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
  8. Service: Indoor or outdoor.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C920.
  1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.
  3. Grade: NS.
  4. Class: 25.
  5. Use: O.

- 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 7. Sealant 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. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
  - F. Round Duct Joint O-Ring Seals:
    - 1. Seal shall provide maximum leakage class of 3 cfm/100 square feet at 1-inch wg (0.14 L/s per sq. m) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
    - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
    - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.06 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## PART 3 EXECUTION

### 3.01 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" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.

- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### **3.02 INSTALLATION OF EXPOSED DUCTWORK**

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### **3.03 DUCT SEALING**

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  2. Outdoor, Supply-Air Ducts: Seal Class A.
  3. Outdoor, Exhaust Ducts: Seal Class A.
  4. Outdoor, Return-Air Ducts: Seal Class A.
  5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-inch wg (500 Pa) and Lower: Seal Class A.
  6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-inch wg (500 Pa): Seal Class A.
  7. Unconditioned Space, Exhaust Ducts: Seal Class A.
  8. Unconditioned Space, Return-Air Ducts: Seal Class A.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-inch wg (500 Pa) and Lower: Seal Class A.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-inch wg (500 Pa): Seal Class A.
11. Conditioned Space, Exhaust Ducts: Seal Class A.
12. Conditioned Space, Return-Air Ducts: Seal Class A.

### **3.04 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 or for slabs more than 4 inches (100 mm) thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
- F. 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.

### **3.05 CONNECTIONS**

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### **3.06 DUCT CLEANING**

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Clean the following components 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.
  4. Coils and related components.
  5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  6. Supply-air ducts, dampers, actuators, and turning vanes.
  7. Dedicated exhaust and ventilation components and makeup air systems.

### 3.07 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

### 3.08 DUCT SCHEDULE

- A. Fabricate ducts as follows:
- B. Supply Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive 1-inch wg (250 Pa).
    - b. Minimum SMACNA Seal Class: A.
  - 2. Ducts Connected to Air Handling Units, Make Up Air Units, and Central Dehumidifiers
    - a. Pressure Class: Positive 2-inch wg
    - b. Minimum SMACNA Seal Class: A
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: A.
- C. Return Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 1-inch wg (250 Pa).
    - b. Minimum SMACNA Seal Class: A.
  - 2. Ducts Connected to Air Handling Units, Make Up Air Units, and Central Dehumidifiers
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class A.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: A.
- D. Exhaust Ducts:
  - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 2-inch wg (250 Pa).
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
  - 2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 1-inch wg (250 Pa).
    - b. Minimum SMACNA Seal Class: A.
  - 2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: A.
- F. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
  - 2. Stainless-Steel Ducts: Stainless steel.
  - 3. Aluminum Ducts: Aluminum
- G. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Velocity 1000 fpm (5 m/s) or Lower:
      - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      - 2) Mitered Type RE 4 without vanes.

- b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm (7.6 m/s) or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
    - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      - 1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      - 2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      - 3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      - 4) Radius-to Diameter Ratio: 1.5.
    - b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
    - c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam.
- H. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: Spin in.
  - 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90-Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
    - a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
    - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
    - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.
- I. Duct Materials
- 1. G90 galvanized steel ductwork (all areas except chemical rooms).
  - 2. Fiberglass FRP (chemical rooms). Refer to nonmetal ductwork specifications.

**END OF SECTION**

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## SECTION 23 31 16

### NONMETAL DUCTS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Thermoset FRP ducts and fittings.
- B. Related Sections:
  - 1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for nonmetal ducts.
  - 2. Section 23 31 13 "Metal Ducts" for single- and double-wall, rectangular and round ducts.
  - 3. Section 23 33 00 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.03 PERFORMANCE REQUIREMENTS

- A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
  - 1. Thermoset FRP duct materials.
  - 2. Hangers and supports.

#### PART 2 PRODUCTS

##### 2.01 THERMOSET FRP DUCTS AND FITTINGS

- A. Manufacturers:
  - 1. Spunstrand.
  - 2. McGill Air Flow.
  - 3. Perry Fiberglass.
- B. Duct and Fittings:
  - 1. Thermoset FRP Resin: Manufacture duct with resin that complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E84.
  - 2. All duct shall be designed for not less than 20-inch water column pressure and 12-inch water column vacuum.
  - 3. Inner Liner: 20 mil thick minimum surface veil saturated vinylester resin. The surface veil shall be overlapped by 1 inch min.
  - 4. Exterior of duct/pipe shall contain sufficient resin to ensure smooth surface free from exposed glass fibers and sharp projections and shall contain ultra violet inhibiting agent.
  - 5. Round Duct: ASTM D 2996, Type I, Grade 2, Class E, filament-wound duct, minimum 0.125-inch (3.2-mm) wall thickness, with tapered bell and spigot ends for adhesive joints, or plain ends with couplings.



6. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and joining method as duct.
  7. Rectangular Fittings: Minimum 0.125-inch- (3.2-mm-) thick flat sheet with fiberglass roving and resin-reinforced joints and seams.
  8. Corrosion resistance and working pressure of fittings shall be equivalent to duct.
  9. Duct joints shall be same material as duct and shall meet or exceed hoop tensile strength and axial strength requirements.
- C. Joining Materials: Roving and polyester resin.
- D. Fabrication:
1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
  2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.
- E. Drains: Formed drain pockets with a minimum of NPS 1 (DN 25) threaded pipe connections.

## 2.02 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables: ASTM A492, stainless steel with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.

## PART 3 EXECUTION

### 3.01 DUCT INSTALLATION

- A. Install ducts with fewest possible joints.
- B. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- C. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- D. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- E. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

- F. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.
- G. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials.
- H. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."

### **3.02 HANGER AND SUPPORT INSTALLATION**

- A. Install hangers and supports for phenolic-foam ducts and fittings to comply with Knauf Insulation's "Knauf KoolDuct System Design Guide," Section 5, "Ductwork System General."
- B. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
- C. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. 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 or for slabs more than 4 inches (100 mm) thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- 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.

### **3.03 PAINTING**

- A. Paint interior of thermoset FRP ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 23 "Interior Painting."

### **3.04 START UP**

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

### **3.05 DUCT SCHEDULE**

- A. Indoor Ducts and Fittings in chemical rooms:
  - 1. Thermoset FRP Round Ducts and Fittings

**END OF SECTION**

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## SECTION 23 33 00

### AIR DUCT ACCESSORIES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Backdraft and pressure relief dampers.
  2. Manual volume dampers.
  3. Control dampers.
  4. Damper Operators.
  5. Turning vanes.
  6. Duct-mounted access doors.
  7. Flexible connectors.
  8. Flexible ducts.
  9. Duct accessory hardware.
  10. Fire Dampers

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 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.
    - b. Manual volume damper installations.
    - c. Control-damper installations.
    - d. Wiring Diagrams: For power, signal, and control wiring.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### PART 2 PRODUCTS

##### 2.01 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

- 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.

## **2.02 MATERIALS**

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90 (Z275).
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- C. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

## **2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS**

- A. Manufacturers:
  - 1. Ruskin.
  - 2. Greenheck.
  - 3. Cesco.
- B. Description: Gravity balanced.
- C. Frame: Hat-shaped, 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners or mechanically attached and mounting flange.
- D. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch (150-mm) width, with sealed edges.
- E. Blade Action: Parallel.
- F. Blade Seals: Felt or Vinyl foam.
- G. Return Spring: Adjustable tension.
- H. Bearings: Steel ball.
- I. Accessories:
  - 1. Adjustment device to permit setting for varying differential static pressure.
  - 2. Counterweights and spring-assist kits for vertical airflow installations.
  - 3. 90-degree stops.

## **2.04 MANUAL VOLUME DAMPERS**

- A. Manufacturers:
  - 1. Ruskin.
  - 2. Greenheck.
  - 3. Cesco.
- B. Fabricate in accordance with SMACNA Duct Construction Standards - Metal and Flexible.

- C. Splitter Dampers:
  1. Material: Same gauge as duct to 24 inches in either direction and two gauges heavier for sizes over 24 inches.
  2. Blade Fabricate of double thickness sheet metal to streamline shape, secure with continuous hinge or rod.
  3. Operator: Minimum 1/4-inch diameter rod in self-aligning, universal joint action, flanged bushing with screw.
- D. Single Blade Dampers: Fabricate for duct sizes up to 6-inch by 30-inch.
- E. Multi-Blade Damper: Fabricate of opposed bladed pattern with maximum blade sizes 8-inch by 72-inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil impregnated nylon or sintered bronze bearings.
- G. Quadrants:
  1. Provide locking, indicating quadrant regulators on single and multiple blade dampers.
  2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
  3. Where rod lengths exceed 30 inches provide regulator at both ends.
  4. Where positioning regulator is not accessible, provide coupling and extension rod with regulator for ceiling.

## 2.05 AUTOMATIC CONTROL DAMPERS

- A. Manufacturers:
  1. Ruskin.
  2. Greenheck.
  3. Cesco.
  4. Arrow United.
- B. Performance: Test in accordance with AMCA 500-D.
- C. Frames: Extruded aluminum, welded, minimum 12 gauge.
- D. Blades: Extruded aluminum, airfoil blades. Maximum blade size 6 inches wide, 48 inches long, minimum 22 gauge, attach to minimum 1/2-inch shafts with set screws.
- E. Blade Seals: Synthetic elastomeric mechanically attached, field replaceable.
- F. Jamb Seals: Spring stainless steel.
- G. Shaft Bearings: Oil impregnated sintered bronze.
- H. Linkage Bearings: Oil impregnated sintered bronze.
- I. Leakage: AMCA - Class 1A. Leakage less than 3 cfm/sq. ft. based on 1-inch w.g. and an approach velocity of 2000 fpm.

## 2.06 DAMPER OPERATORS

- A. Manufacturers:
  1. Honeywell.
  2. Greenheck.
  3. Belimo.

- B. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
  - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
- C. Electric Operators:
  - 1. 120 V, spring return, adjustable stroke having oil immersed gear train, with auxiliary end switch where indicated. Provide NEMA 4X actuator housing.

## 2.07 TURNING VANES

- A. 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.
  - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; 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, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall.

## 2.08 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
  - 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 (25-by-25-mm) 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 (300 mm) Square: No hinges and two sash locks.
    - b. Access Doors up to 18 Inches (460 mm) Square: Two hinges Continuous and two sash locks.
    - c. Access Doors up to 24 by 48 inches (600 by 1200 mm): Three hinges Continuous and two compression latches with outside and inside handles.
    - d. Access Doors Larger than 24 by 48 inches (600 by 1200 mm): Four hinges Continuous and two compression latches with outside and inside handles.

## 2.09 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch (70-mm) wide, 0.028-inch (0.7-mm) thick, galvanized sheet steel or 0.032-inch (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
  3. Service Temperature: Minus 40 to plus 200 degrees F (Minus 40 to plus 93 degrees C).
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
  2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  3. Service Temperature: Minus 50 to plus 250 degrees F (Minus 45 to plus 121 degrees C).

## 2.10 FLEXIBLE DUCTS

- A. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 10 to plus 160 degrees F (Minus 23 to plus 71 degrees C).
- B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 210 degrees F (Minus 29 to plus 99 degrees C).
  4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.
  2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

## 2.11 FIRE DAMPERS

- A. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
- B. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.
- C. Fire Rating: 1-1/2 and 3 hours.
- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.05 (1.3 mm) or 0.39 inch (9.9 mm) thick, as indicated, and of length to suit application.
  2. 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.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.024-inch- (0.61-mm) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.



## 2.12 DUCT ACCESSORY HARDWARE

- A. 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.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 EXECUTION

### 3.01 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 backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.
- E. 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 duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories Coordinate first paragraph below with Section 23 05 53 "Identification for HVAC Piping and Equipment."
- H. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- I. Install flexible connectors to connect ducts to equipment.
- J. Connect diffusers or light troffer boots to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
- K. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- L. Install duct test holes where required for testing and balancing purposes.

### **3.02 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 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.

**END OF SECTION**

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## SECTION 23 34 23

### HVAC POWER VENTILATORS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Centrifugal ventilators.
  2. Ceiling mounted ventilators.
  3. Inline non-metal ventilators.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: 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.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

##### 1.06 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

#### PART 2 PRODUCTS

##### 2.01 CENTRIFUGAL VENTILATORS

- A. Manufacturers:
  1. Greenheck.
  2. Loren Cook.
  3. Penn Barry.
  4. Twin City Fan and Blower.
  5. Hartzell.
- B. Roof downblast, upblast, and sidewall configuration.

- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
  - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
  - 2. Hinged Subbase: Aluminum hinged arrangement permitting service and maintenance.
  - 3. Sidewall Units: Manufacturer's sidewall mounting bracket.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Drive: Direct drive.
- F. AMCA A spark resistant rating where indicated on equipment schedule.
- G. 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 inside fan housing, factory wired through an internal aluminum conduit. Disconnect shall be explosion where indicated on equipment schedule.
  - 3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
  - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- H. Roof Curbs (for roof mounted units): Aluminum; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
  - 1. Overall Height: 18 inches (450 mm), pitched to accommodate sloped roof.
- I. Corrosion Coating: Fan and curb shall include manufacturer's baked epoxy coating.
- J. Motor shall be explosion proof for all fans located in classified areas. Refer to equipment schedule.
- K. Capacities and Characteristics: Refer to equipment schedules.

## 2.02 CEILING-MOUNTED VENTILATORS

- A. Manufacturers
  - 1. Greenheck
  - 2. Loren Cook
  - 3. Penn Barry
  - 4. Twin City Fan and Blower
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Isolation: Rubber-in-shear vibration isolators.
  - 3. Manufacturer's standard roof jack or wall cap, and transition fittings.
- G. Capacities and Characteristics: Refer to equipment schedule.

## 2.03 IN-LINE NON-METAL VENTILATORS

- A. Manufacturers
  - 1. Fantech
  - 2. Engineer approved equivalents.
- B. Fan Housing:
  - 1. Fan housing shall be constructed of UV resistant, flame retardant Polycarbonate (PC) thermo plastic.
  - 2. Fan housing shall be a single piece casing formed by the joining of inlet and outlet pieces via a vibration welding process. The joining process shall not utilize mechanical fasteners, caulk or adhesive, and the seam where the pieces were joined shall be permanent and inherently leak free.
  - 3. Capacitor shall be provided and shall be located within the fan electrical terminal box for easy access. Electrical terminal box is water tight.
- C. Motor:
  - 1. Motorized impeller shall be an external rotor type, class B insulation, totally enclosed PSC Type for maximum efficiency.
  - 2. Motor shall be a permanently sealed self lubricating ball bearing type. Motor shall be equipped with automatic reset thermal overload protection.
  - 3. Motor shall be acceptable for continuous duty.
  - 4. Sufficient service factor shall be provided to ensure long maintenance free operation over maximum load conditions.
- D. Wheel:
  - 1. Fan wheel shall be of the backward inclined centrifugal type with a well designed inlet venturi for maximum performance.
  - 2. Motorized impeller shall be both statically and dynamically balanced as one integral unit to provide for vibration free performance.
- E. Accessories:
  - 1. Backdraft Damper

## 2.04 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "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.
- B. Enclosure Type: Totally enclosed, fan cooled.

## 2.05 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- B. Install units with clearances for service and maintenance.
- C. Label units according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

### **3.02 CONNECTIONS**

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26.
- D. Connect wiring according to Division 26.

### **3.03 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.
- B. Tests and Inspections:
  - 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.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

### **3.04 ADJUSTING**

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 23 05 93 "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.

**END OF SECTION**



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## SECTION 23 51 23

### GAS VENTS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section Includes:
  1. Listed double-wall vents.
  2. Listed special vents
  3. Flexible positive pressure vents
  4. Vents for condensing appliances

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Sample Warranty: For special warranty.

##### 1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

#### PART 2 PRODUCTS

##### 2.01 LISTED TYPE B

- A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 degrees F (248 degrees C) continuously for Type B.
- B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.
- C. Inner Shell: ASTM B 209 (ASTM B 209M), Type 1100 aluminum.
- D. Outer Jacket: Galvanized steel.

- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

## **2.02 LISTED SPECIAL GAS VENTS**

- A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 degrees F (248 degrees C) continuously, with positive or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/2-inch (13-mm) airspace.
- C. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
- D. Outer Jacket: Stainless steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

## **2.03 FLEXIBLE POSITIVE PRESSURE VENT**

- A. Manufacturer's
  - 1. Duravent
  - 2. Engineer Approved Equal
- B. The vent shall be of single wall, factory-built type, designed for use in conjunction with Category I, II, III or IV condensing or non-condensing gas fired appliances or as specified by the heating equipment manufacturer.
- C. Maximum continuous flue gas temperature shall not exceed 480°F (249°C).
- D. Vent shall be listed for a minimum positive pressure rating of 6-inch W.C. and shall have passed at 35-inch W.C.
- E. The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All system components shall be UL listed and supplied from the same manufacturer.
- F. The vent shall be constructed from single-wall overlapped, super ferretic stainless steel, with a minimum wall thickness of .010-inch for 3-inch through 12-inch diameter vents.
- G. All system components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings require to install the vent system shall be UL listed and provided by the vent manufacturer.
- H. Vent layout shall be designed and installed in compliance with manufacturer's installation instructions and all applicable local codes.

## **2.04 VENTS FOR CONDENSING APPLIANCES**

- A. Provide vents, fittings, and accessories constructed of Schedule 40 CPVC where in accordance with appliance manufacturer's recommendations.
- B. Size vents in accordance with appliance manufacturer's requirements.

## **2.05 AUTOMATIC VENT DAMPERS**

- A. Dampers to be electrical/mechanical type, constructed of corrosion resistant materials, AGA certified, UL listed and compete with fail safe safety features.

- B. Control dampers so it is completely open before the burner cycle can start; allow it to open on loss of power or gas valve failure. Close damper when burner cycle ends and flow of fuel has stopped.

## **PART 3 EXECUTION**

### **3.01 APPLICATION**

- A. Listed Type B and BW Vents: Vents for certified gas appliances.
- B. Listed Special Gas Vent: Condensing gas appliances.

### **3.02 INSTALLATION OF LISTED VENTS**

- A. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Lap joints in direction of flow.
- E. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
- F. The vent system shall be routed to maintain minimum clearance to combustibles as specified by the manufacturer.
- G. Vent installation shall conform to the manufacturer's installation instructions, its listing, and state / local codes.
- H. The vent system and breechings shall be inspected and cleaned before the final connection to the appliances.

**END OF SECTION**

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**SECTION 23 55 33.16**

**GAS-FIRED UNIT HEATERS**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 WARRANTY**

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

**1.03 SUMMARY**

- A. Section includes gas-fired unit heaters.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of gas-fired unit heater.
  - 1. Include rated capacities, operating characteristics, and accessories.

**1.05 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

**1.06 QUALITY ASSURANCE**

- A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Modine.
- B. Sterling.
- C. Reznor.

**2.02 PERFORMANCE REQUIREMENTS**

- 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. Capacities and Characteristics: Refer to equipment schedules.

**2.03 MANUFACTURED UNITS**

- A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

- B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- C. Type of Venting: Indoor, power vented, separated combustion where indicated on schedule.
- D. Housing: Steel, with inserts for suspension mounting rods.
  - 1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
  - 2. Discharge Louvers: Independently adjustable, horizontal blades.
- E. Accessories:
  - 1. Four-point suspension kit.
  - 2. Concentric, Terminal Vent Assembly (for separated combustion units): Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes and flashing for wall or roof penetration.
- F. Heat Exchanger: 409 stainless steel.
- G. Burner Material: Stainless steel.
- H. Propeller Unit Fan:
  - 1. Formed-steel or Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
  - 2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
- I. Motors:
  - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
  - 2. Enclosure Materials: Rolled steel.
  - 3. Efficiency: Premium efficient.
  - 4. Totally Enclosed Fan Cooled.
- J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
  - 1. Gas Control Valve: Single stage.
  - 2. Ignition: Electronically controlled electric spark with flame sensor.
  - 3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
  - 4. Vent Flow Verification: Differential pressure switch to verify open vent.
  - 5. Control transformer.
  - 6. High Limit: Thermal switch or fuse to stop burner.
  - 7. Wall-Mounted Thermostat:
    - a. Single stage.
    - b. Fan on-off-automatic switch.
    - c. 24-V ac.
    - d. 50 to 90 deg F (10 to 32 deg C) operating range.
- K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.
- B. Venting materials and installation shall be in strict accordance with manufacturer's guidelines.

### **3.02 EQUIPMENT MOUNTING**

- A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

### **3.03 CONNECTIONS**

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

Gas Piping: Comply with Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

- C. Vent Connections: Vent in accordance with manufacturer's written instruction.
- D. Ground equipment according to requirements of Division 26.
- E. Connect wiring according to requirements of Division 26.

### **3.04 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 2. Verify bearing lubrication.
  - 3. Verify proper motor rotation.
  - 4. Test Reports: Prepare a written report to record the following:
    - a. Test procedures used.
    - b. Test results that comply with requirements.
    - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.05 ADJUSTING**

- A. Adjust initial temperature and humidity set points.
- B. Adjust burner and other unit components for optimum heating performance and efficiency.

### **3.06 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

**END OF SECTION**



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**SECTION 23 82 39.16**

**HORIZONTAL ELECTRIC UNIT HEATERS**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 WARRANTY**

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

**1.03 SUMMARY**

- A. Section includes electric horizontal unit heater and ceiling mounted fan forced heaters.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

**1.05 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data.

**1.06 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connections: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. Conform to applicable NFPA 70 code for internal wiring of factory wired equipment.

**PART 2 PRODUCTS**

**2.01 HORIZONTAL ELECTRIC UNIT HEATERS (CORROSION RESISTANT)**

- A. Manufacturers:
  - 1. Indeeco.
  - 2. Ruffneck.
  - 3. Chromalox.
  - 4. Stellpro.
  - 5. Qmark.
- B. Assembly: UL listed for corrosive areas and NEMA 4X hose down requirements and labeled assembly with terminal box and cover, and built in controls. Units shall be suitable for wet location installation.
- C. Finned tubular heating elements shall be Monel sheath with mechanically wound Monel fins and stainless steel mounting fittings.

- D. Housing: Cabinets, louvers, and rear fan guard shall be 316 stainless steel. Heating elements and motor shall be enclosed in stainless steel housing. Corrosion resistant hardware.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard. Fan blades shall be epoxy coated aluminum.
- F. Motor: Totally enclosed, with permanently lubricated ball bearings.
- G. Controls: NEMA 4X enclosures for; Controlling contactor, fan override, automatic reset thermal cutout, and wall mounted thermostat.
- H. Factory mounted NEMA 4X disconnect.
- I. Stainless steel wall mounting kit.
- J. Entire unit shall be epoxy coated against corrosion.

## **2.02 HORIZONTAL ELECTRIC UNIT HEATERS (INDUSTRIAL GRADE)**

- A. Manufacturers:
  - 1. Indeeco.
  - 2. Ruffneck.
  - 3. Chromalox.
  - 4. Stellpro.
  - 5. Qmark.
- B. Assembly: UL listed and labeled assembly with terminal box and cover, and built-in controls.
- C. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.
- D. Cabinet: Galvanized steel, powder coated finish with integral air outlet grille with adjustable louvers.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard.
- F. Motor: Totally enclosed, with permanently lubricated ball bearings.
- G. Controls: Controlling contactor, fan override, automatic reset thermal cutout, and wall mounted thermostat.
- H. Disconnect: Factory mounted and wired disconnect switch.

## **2.03 PERFORMANCE REQUIREMENTS**

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install unit heaters level and plumb.
- C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Provide factory wall mounting bracket for horizontal unit heaters.

### **3.03 CONNECTIONS**

- A. Ground equipment according to Division 26.
- B. Connect wiring according to Division 26.
- C. Install electric heating equipment including devices furnished by manufacturer but not factory mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's guidelines and requirements of Division 26.

### **3.04 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**END OF SECTION**

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## SECTION 23 82 39.19

### WALL & CEILING UNIT HEATERS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 WARRANTY

- A. Full warranty against defects in materials and workmanship for two years after substantial completion including all parts, labor, and expenses.

##### 1.03 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### PART 2 PRODUCTS

##### 2.01 MANUFACTURERS

- A. Qmark
- B. Indeeco
- C. Chromalox

##### 2.02 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- 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.

##### 2.03 CABINET

- A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Surface Mounting Kit: For surface mounting of wall mounted electric cabinet heaters.

## **2.04 COIL**

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection.

## **2.05 FAN AND MOTOR**

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

## **2.06 CONTROLS**

- A. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Ground equipment according to Division 26.
- E. Connect wiring according to Division 26.

**END OF SECTION**

## SECTION 23 84 16

### DEHUMIDIFIERS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. This Section includes packaged, factory assembled and tested, refrigerant-type, mechanical dehumidification units designed for indoor installation.

##### 1.02 RELATED DOCUMENTS

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

##### 1.03 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.
- E. Warranty: Sample of special warranty.

##### 1.04 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.

##### 1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dehumidification units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than five years from date of Substantial Completion.

##### 1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set(s) of each type of filter specified.



## **PART 2 PRODUCTS**

### **2.01 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.
    - a. Therma-Stor, LLC Model HI-E Dry 195.
    - b. Pre-approved equal.

### **2.02 CASINGS**

- A. Casing: Single-wall construction with corrosion protective coating and exterior baked-enamel finish, stainless-steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.
  - 1. Access: Removable panels with neoprene gaskets.
  - 2. Insulation: Minimum 1/2-inch thick thermal insulation.
  - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- B. Drain Pan and Connection: Stainless steel insulated and complying with ASHRAE 62.1-2004.

### **2.03 FANS**

- A. Supply Fans: Forward curved, centrifugal; galvanized steel with baked-enamel finish; belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing of dehumidification unit.
- B. Fan Motor Enclosure Type: Totally enclosed, fan cooled.

### **2.04 FILTERS**

- A. Glass Fiber:
  - 1. MERV-8.
  - 2. Pleated media.

### **2.05 REFRIGERATION SYSTEM**

- A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1.
- B. Refrigerant Coils: Copper tubes with mechanically bonded aluminum fins; factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits, seamless-copper headers with brazed connections, and galvanized steel frame. Coil and fins shall have a polyester coating. Coils shall have a minimum 300-psig (2070-kPa) working pressure rating and be factory tested to 450 psig (3105 kPa) and to 300 psig (2070 kPa) while underwater.
- C. Compressors: Hermetic, scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.
  - 1. Number of Refrigerant Circuits: One.
  - 2. Refrigerant: R-22.
  - 3. Capacity Control:
    - a. Hot-gas bypass valve and piping
    - b. Cycle compressor.
  - 4. Low-Pressure Cutout: Manual reset after three automatic-reset failures.
  - 5. High-Pressure Cutout: Manual reset.
  - 6. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.

7. Defrost Cycle: Adjustable timer shuts off supply fan. Compressor cycles until suction line temperature confirms thawed evaporator coil.

## **2.06 CONTROLS**

- A. Operating Control: Space humidistat cycles the compressor. Humidistat shall incorporate fan on-off auto switch.

## **2.07 SOURCE QUALITY CONTROL**

- A. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.
- B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to ARI 575.

## **PART 3 PRODUCTS**

### **3.01 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install units level and plumb, maintaining manufacturer's recommended clearances.

### **3.03 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections and prepare test reports:
  1. Charge refrigerant coils with refrigerant 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.
- B. Remove and replace malfunctioning components and retest as specified above.

### **3.04 STARTUP SERVICE**

- A. Perform the following final checks before startup:
  1. Verify that shipping, blocking, and bracing are removed.
  2. Verify that unit is secure on mountings and supporting devices and that connections to 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. Verify lubrication of bearings, pulleys, belts, and other moving parts.
  5. Install clean filters.
- B. Starting procedures for dehumidification units include the following:
  1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
  2. Measure and record motor electrical values for voltage and amperage.
- C. Complete installation and startup checks according to manufacturer's written instructions.
- D. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

### **3.05 ADJUSTING**

- A. Adjust initial temperature and humidity set points.

### **3.06 CLEANING**

- A. Clean dehumidification 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, testing, and startup service of dehumidification units, clean filter housings and install new filters.

### **3.07 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

**END OF SECTION**

## SECTION 26 00 00

### GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 GENERAL

- A. Scope of Work:
  - 1. The work included under Division 26 shall consist of furnishing labor and materials necessary for the complete installation of the electrical systems shown on the Contract Drawings and described in the Specifications. This shall include minor items which are necessary to complete the installation and usually included in similar work even though not specifically mentioned in the Contract Documents.
  - 2. Contractor shall walk through the installation at site with Owner's representative prior to mounting equipment and routing conduit.
  - 3. Include minor items which are obviously and reasonable necessary to complete the installation and usually included in similar work even though not specifically mentioned in the Contract Document.
  - 4. Deviations due to particular manufacturer's requirements shall be provided at no additional cost.
  - 5. Contractor is responsible for the coordination of the installation of electrical equipment with other trades. Where conflicts between disciplines arise, contact the Engineer prior to equipment installation.
  - 6. Factory-trained manufacturer's representative to provide operator training as specified in Sections 01 75 00 and 01 77 00.
  - 7. Provide as-built drawings and documents as required by Section 01 77 00.
- B. Related Requirements:
  - 1. The Contractor is responsible for information contained in the Division 26 Specifications in addition to electrical requirements and information contained in other divisions.
  - 2. Where a Specification Section refers to other sections under the Article of Related Requirements, this is done for Contractor's Convenience only. It shall not relieve the Contractor of responsibilities stated in other Sections of the Specifications. The Contractor is responsible for information contained in this division's Specifications as well as for electrical requirements and information contained in other divisions.

##### 1.03 PERMITS, LICENSES, AND FEES

- A. Provide temporary and permanent permits and licenses required for the completion of the work included under this contract. Fees and expenses required to obtain such permits shall be paid for by the Contractor.
- B. Fees and costs charged by utility companies for utility services, or modifications to, shall be **[paid for by the Owner] [paid for out of the Utility Allowance – See Section 01 21 00 – Allowances]**.
  - 1. Contractor to coordinate with Owner, (Madison Water Utility), and Madison Gas and Electric for electrical service.
    - a. Madison Gas and Electric will provide primary service to transformer location.
    - b. Contractor is responsible for transformer pad, PTs, CTs and VTs, and primary stubout.
    - c. Contractor is responsible for all secondary wiring from the utility transformer.
    - d. Contractor is responsible for meter socket.
    - e. See commercial installation requirements on Xcel Energy's website for details.

2. Contractor to coordinate application for electrical service with Utility and the Owner.
    - a. Contractor shall obtain application and submit the application to the Utility.
    - b. Contractor to coordinate with Engineer for completion of the load sheet.
    - c. Contractor to meet with Utility representative on-site after submittal of the application to coordinate the installation.
    - d. Madison Gas and Electric account manager:
  3. Contractor to coordinate with communications system provider for connection of internet and phone services.
    - a. Contactor shall contact supplier and arrange for services to be installed to location as shown on the plans.
  4. Project Address:  
XXXXXXXXXXXX  
Madison, WI XXXXX
- C. Provide inspections as required by regulating agencies or where required by code. Include and pay charges for inspection agencies and provide Owner with a certificate of final inspection and approval by the authority having jurisdiction.
- D. Refer to General Conditions for state and local sales tax requirements.

#### 1.04 REFERENCES

- A. Material and workmanship to comply with applicable codes. As a minimum include State and Federal laws, local ordinances, Utility Company regulations and requirements and interpretations of the following by the local authority having jurisdiction:
1. State and Local Building Codes.
  2. State and Local Fire Codes.
  3. National Electrical Code.
  4. State and Local Electrical Codes.
  5. OSHA Regulations.
- B. If drawings and specifications are in conflict with these codes, notify the Engineer prior to rough-in.
- C. The following is list of organizations and their abbreviations where referred to in the specifications as standards of construction:
1. ANSI – American National Standard Institute.
  2. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers.
  3. ADA – Americans with Disabilities Act.
  4. ASTM – American Society for Testing and Materials.
  5. FM – Factory Mutual.
  6. IRI – Industrial Risk Institute.
  7. IEEE – Institute of Electrical and Electronic Engineers.
  8. NBFU – National Board of Fire underwriters.
  9. NBS – National Bureau of Standards.
  10. NEC – National Electrical Code.
  11. NEMA – National Electrical Manufacturers Association.
  12. NFPA – National Fire Protection Agency.
  13. OSHA – Occupational Safety and Health Administration.
  14. UL – Underwriters' Laboratories, Inc.

#### 1.05 DEFINITIONS

- A. The terms listed below are defined as followed:
1. Furnish: Obtain, coordinate, deliver to the job site and guarantee.
  2. Install: Furnished by others, receive on site, unload, store, set in place, connect, place in operation and guarantee workmanship of installation.
  3. Provide: Furnish and install.
  4. Connect: Bring service to the equipment and make final attachments, including necessary disconnect switches, control switches, outlets, etc.

5. Conduit: Electrical conduit and associated fittings, hangers, pull boxes, supports, etc. as required for a complete and proper installation.
6. Concealed: Hidden from sight in walls, ceilings or floors.
7. Exposed: Surface mounted, not hidden from site.
8. Building Structure: Columns and beams.
9. Relocate: Existing equipment to be relocated to new location and existing conduit and branch circuiting (conductors) to be extended to new location and reconnected.
10. Circuitry: Conduit, conductors and connections for a complete operational system.

#### **1.06 SUBMITTALS**

- A. Substitutions shall be submitted through a bidding contractor and submitted to engineer 10 working days prior to bid opening. Include detailed information concerning substitution. Acceptable substitutions will be issued in an addendum to the Contract Documents prior to bid date. Extra costs incurred as a result of substitution, including those of other contractors are the responsibility of the submitting contractor, including engineering redesign cost.
- B. Shop drawing submittals shall be done in accordance with the General Conditions and as listed under Division 1. Submit copies for each item as required per individual section of the specifications.
- C. Submit Record Drawings in accordance with the General Conditions and as listed under Division 1. Record Drawings shall consist of one complete set marked up with changes completed during construction. Multiple set of markups is will not be accepted and must be transferred to one site prior to submittal.
- D. Submit Operating, Maintenances and Warranty Data Manuals in accordance with the General Conditions and as listed in Division 1.

#### **1.07 PROJECT/SITE CONDITIONS**

- A. Inspection of Site: Before submitting a proposal on the Work, the Contractor and Subcontractors shall examine the site of the proposed work and thoroughly familiarize themselves with existing conditions and limitations affecting the performance of their Work. No extra compensation will be allowed because of a misunderstanding as to the amount of Work involved or lack of knowledge of existing conditions which could have been discovered or reasonable anticipated prior to bidding.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Engineer before proceeding.

#### **1.08 STORAGE AND HANDLING**

- A. Protect electrical equipment and components stored or installed on-site with polyethylene or equivalent covering to protect from moisture, plaster, cement, paint, or work of other trades.
- B. Additional protective coverings may be constructed of plywood sheeting for additional strength.
- C. Replace or touch up and refinish surfaces of original finishes that becomes chipped or scratched during shipment or installation.

#### **1.09 TEMPORARY ELECTRICAL SERVICE**

- A. Provide and maintain electrical power service for the use of all trades during construction.
  1. Contractor is responsible for all costs and charges associated with the temporary power connection and service for the duration of the construction period.
  2. Provide and maintain a complete temporary lighting services for use by all trades during construction.
    - a. Provide adequate lighting suitable for conditions for high quality workmanship and for safety throughout the area of construction. Provide minimum requirements of one (1) 200-watt luminaire per each 400 square feet or per room.

- b. Provide and maintain an exit and safety lighting system where required by code or OSHA.
  - 3. Refer to General Conditions for additional temporary power service requirement details.
  - 4. Refer to General Conditions for any phasing or additional requirements.
- B. Provide and maintain a complete temporary power system for facilities being removed, but are to remaining functional until new facilities are operations. See sequence of construction.
  - C. Provide and maintain services to existing facilities until new facilities are operational. See sequence of operation to sequence electrical services.

#### **1.10 EQUIPMENT SIZE COORDINATION**

- A. Equipment placement on design drawings is based from one manufacturer's dimensions. Coordinate the actual size of manufacturer used with the spaces available and alert Engineer if there is issue with fitting the proposed equipment into the space.
- B. Investigate each space in structure through which equipment must pass to reach its final location. Coordinate shipping splits with manufacturer to permit safe handling and passage through restricted areas in structure.
- C. Equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace equipment to ensure that tilting does not impair the functional integrity of equipment.

#### **1.11 TEMPORARY SHUTDOWNS AND ABANDONED SERVICES**

- A. Where the work makes temporary shutdowns unavoidable, contractor shall consult with owner as to times and procedures for such shutdowns. Where existing services are abandoned, wiring shall be removed and conduit shall be properly capped in conformance with the requirements of the utility.
- B. Existing systems are to remain functional until new facilities are complete and operational.

#### **1.12 SEQUENCING AND SCHEDULING**

- A. Install work to accommodate Owner's occupancy requirements during construction period and coordinate electrical schedule and operations with owner.
- B. Construct work in a sequence under provisions of division 01 – General requirements and other sections as applicable.
- C. Electrical work shall be coordinated with other trades and contractors to expedite completion of project.
- D. It will be the contractors responsibility to examine the drawings and specifications, to take measurements where required to verify dimensions for correct placement of equipment and to progress the contract as expeditiously as possible, so that the progress of the work is orderly and does not cause unnecessary cutting and patching of structures. The contractor shall be responsible for cutting and patching of structures made necessary by the failure to install sleeves, grilles or other items required by the electrical work at the proper time for the normal installation of such items.
- E. The determination of quantities of material and equipment required shall be made by the contractor based on the contract documents. Schedules on the drawings and in the specifications are completed as an aid to the contractor but where discrepancies arise, the actual number required shall govern.

#### **1.13 RECORD UTILITES DRAWINGS**

- A. Contractor shall prepare and submit to Engineer, drawings showing the exact location of all installed underground electrical and conduit runs and any existing underground utilities encountered during installation. The drawings shall give accurate locations (referenced to visible above-grade objects) and

dimensions of all such equipment for future use by the owner. These drawings shall be submitted to Engineer as soon as possible after such runs have been installed.

#### **1.14 WARRANTY**

- A. Provide a guarantee of workmanship and material and keep same in good operating condition for a period of one (1) year after final completion of the work as evidenced by issuance of final completion certificate by the Engineer.
- B. Correct defects immediately and at contractors expense those defects due to faulty workmanship or materials that arise during the above mentioned period and make corrections to the satisfaction of the Engineer. Such reconstruction and repairs shall include damages to the finish of the building resulting from the original defect.
- C. The guarantee shall not apply where other guarantees for different lengths of time are specifically called for.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

##### **3.01 ROUGH-IN**

- A. Verify location for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Consult the Contract Documents (Drawing and Specifications) of other Divisions and other trades for correlating information and layout work so that it will not interfere with other trades. Verify dimensions and conditions; i.e., finished ceiling heights, wall elevations, sections, footing and foundation elevations, beam depths, ductwork and piping etc. with architectural, mechanical, civil, and structural drawings. If conflicts occur such that resolution is not possible by the affected trades on the job, notify the Engineer so a resolution can be worked out. Where work must be replaced due to failure to verify conditions existing on the job, such replacement shall be accomplished at no extra cost to the owner. This shall apply to shop fabricated Work as well as work fabricated in place.

##### **3.02 INSTALLATION**

- A. Arrange for chases, slots, and openings in other building components during the progress of construction to allow for electrical installation.
- B. Install material and equipment in accordance with manufacturers' recommendations, instructions and current NECA, NFPA 70 and UL standards.
- C. Install equipment and materials to provide required access for servicing and maintenance. Coordinate equipment location with required access panels and doors. Allow ample space for removal of parts that require replacement or servicing.
- D. Coordinate the installation of required supporting devices and sleeves with structural systems.
- E. Coordinate with other trades before installing equipment so that conflicts will be resolved before installation. In general large mechanical equipment shall be given priority. Maintain, wherever practical, a minimum separation of 3 inches from water and waste piping and 12 inches from hot water and steam piping.



- F. Electrical Equipment, outlet boxes, etc. shall not be attached or otherwise fastened to ductwork or other mechanical equipment unless noted otherwise.
- G. Cutting and patching shall be performed in accordance with the provisions of the general conditions.
- H. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed unless noted otherwise.
- I. Drilling:
  - 1. Drill holes in masonry with rotary drills.
  - 2. Properly seal penetrations with an approval fire-rated sealant.
  - 3. Verify fire rating of walls prior to work and restore to required fire rating.

### **3.03 PROTECTION**

- A. Contractor shall be responsible for damage to electrical equipment or materials. Equipment installed by the Contractor shall be kept in a clean and functional condition until final acceptance by the Owner.
- B. When a portion of the building is to be occupied by the Owner prior to Substantial Completion of the entire Project, arrangements will be made to transfer responsibility for protection and housekeeping tasks from the Contractor to Owner.
- C. There shall be no interruptions of building systems during occupied times without prior arrangement.

### **3.04 CLEANING**

- A. Keep the premises free from the accumulations of waste materials or rubbish caused by execution of the Work. At the completion of the Work, remove rubbish, tools, scaffolding and surplus material from and about the premises. The premises shall be "broom-cleaned" or its equivalent, unless more thorough cleaning is specified elsewhere.

### **3.05 PAINTING**

- A. Refinish electrical equipment damaged during shipping or installation to its original condition. Remove rust, prime and paint per manufacturer's recommendations for finished equal to original. Do not paint nameplates, labels, tags, stainless steel or items such as shafts, levels, handles, trim or terminal strips.
- B. Conduit and raceway systems shall be unpainted unless specifically noted. If painting of conduit and raceway systems is required, coat with paint type and color to match background mounting surface.
- C. Touch-up paint shall be applied to equipment with chips or scratch marks.

### **3.06 OPENINGS, CUTTING AND PATCHING**

- A. The contractor shall coordinate the placing of openings in structures as required for the installation of electrical work.
- B. The contractor shall coordinate the accurate location and size for required openings and shall assure that the proper size openings are provided. Openings shall be patched and/or sealed.
- C. Contractor shall provide cutting and patching as required for the installation of the work, and shall furnish lintels and supports as required for openings. Cutting of the structural members will not be permitted without prior approval of the Engineer. Extent of the cutting shall be minimized by use of core drills, power saws or other machines which will provide neat, minimum openings. Patching shall match adjacent materials and surfaces and shall be performed by craftsman skilled in the respective discipline.

### **3.07 TEST AND DEMONSTRATIONS**

- A. Systems shall be tested and placed in proper working order prior to demonstrating to Owner.
- B. Prior to acceptance of the electrical installation, the contractor shall demonstrate to the Owner or Owner's designated representative all essential features and functions of the systems installed and shall instruct the owner in the proper operation and maintenance of such systems.
- C. Contractor shall furnish the necessary trained personnel to perform to demonstrations and training and shall arrange to have the manufacturers' representatives for the system present to assist with the demonstration, the owner and contractor shall each sign a certification stating that the training has been performed and the owner accepts the same.

### **3.08 CONCRETE WORK**

- A. The contractor shall coordinate size and location of concrete bases and pads for electrical equipment with the required trades and with the utility.
- B. The contractor shall furnish equipment anchor bolts and shall be responsible for their proper installation and accurate location.

### **3.09 EXCAVATING, TRENCHING AND BACKFILLING**

- A. The contractor shall do excavating necessary for underground electrical ducts, wiring manholes, conduit, etc. and shall backfill such trenches and excavations after equipment has been installed and tested. Care shall be taken in excavating, so that walls and footings and adjacent load bearing soils are not disturbed, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe.
- B. Excavations shall be kept free from water by pumping if necessary. No greater length of trench shall be left open, in advance of pipe and utility laying, than necessary.
- C. Immediately after testing and/or inspection, the trench shall be carefully backfilled. Place backfill into trench, so the impact on installed pipe is minimized. Backfill and compact to specifications described in division 02 for utility trenching.

**END OF SECTION**

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## SECTION 26 05 01

### ELECTRICAL DEMOLITION

#### PART 1 GENERAL

##### 1.01 SCOPE

- A. This Section covers basic electrical requirements for providing labor, materials, equipment, and services necessary to complete all the demolition required for the project as specified herein and shown on the drawings.

##### 1.02 INTENT

- A. It is the intent of this specification and accompanying drawings to describe the overall scope of demolition work to be performed. It is not intended that the specifications and drawings show every piece of equipment required to be removed.
- B. The contractor shall disconnect and remove electrical items as indicated on the drawings, or as required by the project.
- C. The contractor shall seal floor, wall and ceiling openings with thermo-setting fire resistive compound after removal of conduits.
- D. The Wastewater Treatment Plant shall be capable of operating at all times.

#### PART 2 PRODUCT

Not Used

#### PART 3 EXECUTION

##### 3.01 DEMOLITION/ALTERATION

- A. Prior to start of demolition, disconnect power and control at the source. Contractor shall verify using an electrical meter or other device to ensure that power has been disconnected at the source of supply.
- B. Demolition shall be performed in such a manner as to avoid hazards to persons and property. Work shall be performed in strict accordance with all Municipal, State and Federal Rules, Regulations, Codes, and Laws which may govern and apply to this work.
- C. Maintain continuous service of feeders, circuits or partial circuits, and outlets affected by this work, except where written permission for an outage for a specified time has been granted. All work requiring shut down of existing systems shall be coordinated and approved by Owner prior to work starting.
- D. Provide reconnection and temporary installation as required; remove at job completion.
- E. Cut back to floor, wall, or ceiling and plug ends of concealed conduits made obsolete. Remove exposed conduits, wireways, outlet boxes, hangers, and devices made obsolete by this work unless designated specially to remain.
- F. Provide blank plates on all unused outlet boxes.

- G. Wherever extensions of wires or cables are shown on drawings, check and verify wire and cables size and capacities. Secure Engineer acceptance of this data before new cables are ordered or installation starts.
- H. The Owner reserves the right to claim any materials removed during demolition that will not be reused.
- I. Repair existing surfaces back to original condition.

### **3.02 WASTE MANAGEMENT**

- A. Contractor is responsible to remove from the site all material not salvage or retained by the owner.
- B. The contractor shall be responsible for all damage to existing materials not affected by the demolition work. The contractor shall repair or replace damage material or equipment as directed at no additional cost to the owner.

**END OF SECTION**

## SECTION 26 05 10

### MOTORS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Process equipment, ventilation and general purpose motors.

##### 1.02 REFERENCES

- A. Anti-Friction Bearing Manufacturers Association (AFBMA)
  - 1. Load Ratings and Fatigue Life for Ball Bearings
- B. Institute of Electrical and Electronic Engineers (IEEE)
  - 1. 112A
    - a. Test Code for Polyphase Induction Motors and Generators.
- C. National Fire Protection Association (NFPA):
  - 1. NFPA 70
    - a. National Electrical Code (NEC), 2011
- D. National Electrical Manufacturer's Association (NEMA).
  - 1. NEMA MG1
    - a. Motors and Generators.
  - 2. NEMA 250
    - a. Enclosures for Electrical Equipment.

##### 1.03 SUBMITTALS

- A. Shop drawings and product literature in conformance with Section 01 33 00 and including:
  - 1. Dimension drawings
  - 2. Wiring diagrams
  - 3. Equipment mechanical and electrical specification sheets
  - 4. Efficiency information
- B. Submit operation and maintenance data in accordance with Section 01 75 00, unless such data is included in the data provided for individual equipment items.
- C. Submit information to allow Owner to apply for utility rebates for premium-efficiency motors. Submit motor efficiency data and copies of receipts for all premium-efficiency motors, showing motor price, model number and date of delivery.

##### 1.04 DELIVERY, STORAGE AND HANDLING

- A. Motors shall be covered and stored in a dry, warm (50°F) location prior to installation.
- B. Once installed, the space shall be heated and kept dry. The motor shall be covered until ready for service. Covering shall not trap moisture in the motor.

## PART 2 PRODUCTS

### 2.01 MOTORS

- A. Motors shall conform to applicable NEMA, IEEE, and ANSI standards. Motors using non-standard frames or otherwise constructed using special characteristics will be permitted only by special permission of the Engineer, the intent being to confine such usage to cases where such characteristics are required.
- B. Motor ratings shall be based on current NEMA design standards for continuous duty and/or multiple starts per hour on motors through 100 horsepower. On motors larger than 100 horsepower starting shall be based on NEMA MG1-20.43 number of starts. All motors 1 horsepower and larger shall have a 1.15 service factor. Wherever horsepower ratings of motors proposed differ from those shown or specified, this fact shall be prominently noted on the shop drawings submitted, or otherwise brought to the attention of the Engineer.
- C. Process and major equipment drive motors shall be 3 phase, squirrel-cage induction type NEMA Design B, dual voltage in all sizes and types where this rating is standard. Larger motors and special motors where dual voltage construction is not available shall be furnished in ratings consistent with the nominal system voltage. Where process drives of fractional horsepower are required, standard frame 56 units shall be supplied. Such drives requiring limited power input shall employ overload heaters undersized accordingly.
- D. General purpose single phase motors, 1/3 HP and smaller, shall be 115 volt capacitor start type designed for continuous duty. Light duty motors of the domestic appliance variety will not be acceptable in this work. Bearings on frame 56 fractional horsepower motors shall be of the anti-friction or sleeve type.
- E. The division furnishing motors, or equipment containing or including motors, shall be responsible for delivery, handling and setting regardless of local agreements as to actual work jurisdiction. Further, this responsibility shall include checking of lubrication, drive alignment and condition, indication of proper rotation, and any or all other matters relating to operative readiness. When all checks are satisfactorily accomplished, the readiness of the unit for operation shall be indicated by a conspicuous and legible tag installed by the responsible individual.
- F. As part of the operational test the responsible Division shall arrange for checking and recording of load current and verification of rating of overload heaters. No unattended operation of the equipment shall be permitted until completion of this procedure.
- G. Motor frames shall be totally enclosed fan cooled unless otherwise specified.
- H. All motors larger than NEMA 56 frame shall have anti-friction (ball or roller) bearings, sized for a B-10 life of at least 30,000 hours under normal loading conditions. Bearing shall be AFBMA standard sizes. Motors shall be equipped with endshield-mounted ball bearings made to AFBMA standards, and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent re-lubrication, but facilities shall be provided for adding new grease and draining out old grease without major motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of grease out of the bearing cavity.
- I. Balance and Vibration:
  - 1. The vibration in any direction, as measured at the bearing housings, with the motors running at normal voltage and frequency, the shaft axis in normal position, and with one-half of a standard key in the keyway shall conform with the following:

## **VIBRATION LIMITS**

Maximum Permissible Total Amplitude Peak to Peak (In.)

Frame Diameter Series	SYNCHRONOUS SPEED (RPM)		
	Below 1700	1700-3499	3500 & Above
180,210,220	0.002	0.0015	0.001
250,280,320	0.002	0.0015	0.001
360,400,440	0.002	0.0015	0.001

2. If balancing weights are added to the rotor, they shall be permanently secured by welding, peening, or other method approved by the Engineer.
- J. Materials:
1. Stator Frames and Endshields as Follows:
    - a. Drip-proof and Standard Duty-TEFC: Stator frames and endshields, may be cast aluminum, steel, or cast iron, whichever is manufacturer's standard.
    - b. Severe Duty - TEFC and Explosion-Proof: Frames and endshields shall be cast iron for all frame sizes. Extruded aluminum frames will be considered with prior approval.
  2. Other External Parts as Follows:
    - a. Drip-proof and Standard Duty - TEFC: Fan covers and conduit boxes may be cast iron, aluminum or steel, depending on manufacturer's standard.
    - b. Severe Duty - TEFC and Explosion-Proof: Fan covers and conduit boxes shall be cast iron.
- K. Conduit Boxes:
1. Conduit box mountings shall be arranged so conduit can be brought in from top, bottom or either side. Cast iron conduit boxes for all severe duty motors shall be tapped or threaded conduit connection. Conduit hole size shall conform to NEC Standards, depending on motor rating.
- L. Eyebolts:
1. All motors weighing more than 50 lbs. shall be drilled and tapped for a lifting eyebolt.
- M. Motor Leads:
1. Motor leads into conduit box shall have same insulation class as the winding, and be equipped with a numbered brass or copper terminal staked or otherwise mechanically fastened to the lead sufficient to resist 15 lbs. pull. Leads shall be marked throughout the entire length to provide identification after terminals are taped or clipped.
- N. Ventilating Fans:
1. Drip-proof and TEFC: The fans forcing ventilating air through or over a motor may be steel, aluminum, or molded plastic, whichever is manufacturer's standard.
  2. Severe Duty - TEFC and Explosion Proof: Ventilating fans shall be non-sparking, abrasion and chemical resistant, cast brass or polypropylene.
- O. Shaft Seals:
1. All severe duty motors and TEFC motors, 254 frame and larger, shall have a rotating seal or slinger located on the shaft at the drive end endshield opening to prevent moisture or other foreign material from entering the bearing cavity.



P. Nameplates:

1. Aluminum nameplates may be used on drip-proof and standard TEFC motors. Severe duty enclosed motors shall have nameplates of stainless steel. Nameplates shall be stamped to include the following information:
  - a. Horsepower (not including 15% S.F.)
  - b. Speed
  - c. Time Rating
  - d. Frequency
  - e. Phases
  - f. Model Number
  - g. Rated Voltage
  - h. Service Factor (1.15 on all motors 1 HP and larger)
  - i. Full Load Amps (based on nameplate HP, not including 15% S.F.)
  - j. Insulation Class
  - k. NEMA Design
  - l. NEMA Code Letter
  - m. Maximum Ambient
  - n. Bearing Identification

Q. Connection Diagrams

1. The motor connection diagram shall be permanently attached to the motor either inside the conduit box or on the motor frame in a readable location from the conduit box side.

R. Locked Rotor Characteristics:

1. Unless shown otherwise, motors with a nameplate rating of 5 to 20 horsepower shall have a locked rotor characteristic not exceeding Code H. Motors with a nameplate rating of 25 through 50 horsepower shall not exceed NEMA Code G locked rotor characteristics. Motors larger than 50 horsepower shall not exceed NEMA Code F locked rotor characteristics.

S. Severe Duty:

1. Motors designated for severe duty shall have the following characteristics in addition to those designated in the specification:
  - a. Stainless steel nameplate.
  - b. Cast iron housing, bearing brackets, fan guard.
  - c. Cast iron conduit box.
  - d. Cast brass or polypropylene fan.
  - e. Zinc plated hardware.
  - f. Minimum of 2 extra epoxy varnish, or equal, dips and bakes on windings.

T. Inverter Duty:

1. Motors operated by a solid-state inverter variable frequency drive (VFD) shall be provide with inverter duty rated motor. **Inverter Ready is not acceptable.**
2. Motors designated for inverter duty shall have the following characteristics in addition to those designated in this Specification:
  - a. Specifically designed for use with a solid-state inverter variable frequency drive (VFD).
  - b. Minimum service factor of 1.00 when operating from a VFD.
  - c. 1600V insulation system designed for inverter duty.
  - d. Insulated bearing on the non-drive end to eliminate circulating currents for motors 150 hp and larger.
  - e. Thermal switch embedded in the motor windings to stop the VFD on motor overtemperature condition. Normally-closed contacts rated 5A at 120 VAC, nominal.

U. Heater:

1. Where specified in the process equipment section, motors shall contain internal heaters to operate on 120 VAC to minimize condensation inside the motors. Unless otherwise required, the nominal heater size shall be 150 VA.

- V. External Finish:
1. All motors shall be prime painted with corrosion resisting metal primer, and finish painted with a durable machinery gray enamel, manufacturer's standard unless otherwise specified.
  2. All bolts, screws, and other external hardware shall be treated by zinc with irridite or zinc chromate for resistance to corrosion.
- W. Testing:
1. Motor testing procedure shall be in accordance with the American Standard Test Code for polyphase induction motors and generators, IEEE 112A. All motors shall be given routine test to determine that they are free from electrical or mechanical defects. The routine test shall, as a minimum, conform to MG1-12.51.
- X. Preparation for Shipment:
1. Before shipment, the shaft extension and any other bare exposed metal parts of each motor shall be coated with an easily removable rust preventative.
  2. All motors shall be securely fastened to a hardwood skid or pallet for fork truck handling, and be covered for protection against dirt and moisture during transit and for short time outdoor storage.
- Y. Operating Characteristics:
1. Motors shall meet or exceed the starting locked rotor and maximum breakdown torques specified by NEMA for the NEMA design. The locked rotor starting currents shall not exceed NEMA maximum values for the specified NEMA design and rating. The current density and heating characteristics shall be such that the motors will not suffer damage if subjected to a maximum of ten (10) seconds stall at six times full load current. Except as noted, the services factor of the motor shall be in accordance with NEMA Standards. The insulation system of the motor shall be designed for 40,000 hours operation under usual service conditions as described under NEMA 1-14.02. The motor manufacturer shall use IEEE standards to establish the suitability of the insulation system to meet these requirements.
- Z. Energy Efficiency:
1. Motors 1 horsepower and larger shall be of the energy efficient type. Energy efficient motors shall have a 1.15 service factor rating.
  2. Efficiency shall be defined as the ANEMA Nominal Efficiency@at full load, as detailed in NEMA MG-1-12.54.1, and shall meet or exceed the values in the following tables. If a higher value is specified in the respective equipment section, then the higher value shall apply.

**FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS**

OPEN MOTORS			HP	CLOSED MOTORS		
1200 RPM	1800 RPM	3600 RPM		1200 RPM	1800 RPM	3600 RPM
82.5	85.5	77.0	<b>1.0</b>	82.5	85.5	77.0
86.5	86.5	84.0	<b>1.5</b>	87.5	86.5	84.0
87.5	86.5	85.5	<b>2.0</b>	88.5	86.5	85.5
88.5	89.5	85.5	<b>3.0</b>	89.5	89.5	86.5
89.5	89.5	86.5	<b>5.0</b>	89.5	89.5	88.5
90.2	91.0	88.5	<b>7.5</b>	91.0	91.7	89.5
91.7	91.7	89.5	<b>10.0</b>	91.0	91.7	90.2
91.7	93.0	90.2	<b>15.0</b>	91.7	92.4	91.0
92.4	93.0	91.0	<b>20.0</b>	91.7	93.0	91.0
93.0	93.6	91.7	<b>25.0</b>	93.0	93.6	91.7
93.6	94.1	91.7	<b>30.0</b>	93.0	93.6	91.7
94.1	94.1	92.4	<b>40.0</b>	94.1	94.1	92.4
94.1	94.5	93.0	<b>50.0</b>	94.1	94.5	93.0
94.5	95.0	93.6	<b>60.0</b>	94.5	95.0	93.6
94.5	95.0	93.6	<b>75.0</b>	94.5	95.4	93.6
95.0	95.4	93.6	<b>100.0</b>	95.0	95.4	94.1
95.0	95.4	94.1	<b>125.0</b>	95.0	95.4	95.0
95.4	95.8	94.1	<b>150.0</b>	95.8	95.8	95.0
95.4	95.8	95.0	<b>200.0</b>	95.8	96.2	95.4
95.4	95.8	95.0	<b>250.0</b>	95.8	96.2	95.8
95.4	95.8	95.4	<b>300.0</b>	95.8	96.2	95.8
95.4	95.8	95.4	<b>350.0</b>	95.8	96.2	95.8
95.8	95.8	95.8	<b>400.0</b>	95.8	96.2	95.8
96.2	96.2	95.8	<b>450.0</b>	95.8	96.2	95.8
96.2	96.2	95.8	<b>500.0</b>	95.8	96.2	95.8

## **PART 3 EXECUTION**

### **3.01 START-UP**

- A. Check lubrication, drive alignment and condition, indication of proper rotation, and other matters relating to operative readiness. When all checks are satisfactorily accomplished, the readiness of the unit for operation shall be indicated by a conspicuous and legible tag.
- B. Arrange for checking and recording of load current and verification of rating of overload heaters. No unattended operation of equipment shall be permitted until completion of this procedure.

### **3.02 COORDINATION**

- A. Motors operated by a solid-state inverter variable frequency drive (VFD) shall be coordinated with VFDs being provided to operate motor, prior to ordering motor.

**END OF SECTION**

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## SECTION 26 05 19

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  1. Copper building wire rated 600 V or less.
  2. Fire-alarm wire and cable.
  3. Connectors, splices, and terminations rated 600 V and less.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

#### PART 2 PRODUCTS

##### 2.01 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. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  1. Alpha Wire Company.
  2. American Insulated Wire Corporation.
  3. Belden Inc.
  4. Cerro Wire LLC.
  5. Encore Wire Corporation.
  6. General Cable Corporation.
  7. Southwire Company.
  8. WESCO
  9. Approved Substitution.
- 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 B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:
  1. Type THWN-2: Comply with UL 83.
  2. Type XHHW-2: Comply with UL 44.

## 2.02 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs 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.
- B. Manufacture: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Electrical Products.
  - 2. AFC Cable Systems.
  - 3. Gardner Bender.
  - 4. Hubbell Power Systems, Inc.
  - 5. Ideal Industries, Inc.
  - 6. ILSCO.
  - 7. NSi Industries LLC.
  - 8. O-Z/Gedney.
  - 9. Service Wire Co.
  - 10. Approved Substitution.
- 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 or two hole with standard barrels.
  - 3. Termination: Compression.

## PART 3 EXECUTION

### 3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

### 3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.
- B. Feeders: Type XHHW-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.
- C. Branch Circuits: Type THWN-2, single conductors in raceway #4 AWG smaller, or Type XHHW-2, single conductors in raceway #2 AWG and larger.

### 3.03 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 26 05 33 "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 26 05 29 "Hangers and Supports for Electrical Systems."

### **3.04 MINIMUM SIZES**

- A. Minimum control circuit conductor sizes:
  - 1. Class 1 remote-control and signal circuits; No 16 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 14 AWG.
- B. Minimum building wire and power conductor size shall be No. 12 AWG for power and lighting circuits, and No. 14 AWG for control circuits. In order to minimize voltage drop for longer runs, the following minimum conductor sizes apply:
  - 1. 20A, 120V circuits longer than 75 feet: No. 10 AWG minimum.
  - 2. 20A, 120V circuits longer than 150 feet: No. 8 AWG minimum.
  - 3. 20A, 120V circuits longer than 300 feet: No. 6 AWG minimum
  - 4. 20A, 277V circuits longer than 150 feet: No. 10 WG minimum.
  - 5. 20A, 277V circuits longer than 300 feet: No. 8 AWG minimum.

### **3.05 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.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

### **3.06 IDENTIFICATION**

- A. Identify and color-code conductors and cables according to Section 26 05 53 "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.

### **3.07 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 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### **3.08 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 07 84 13 "Penetration Firestopping."

### **3.09 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
  - 1. Generator
  - 2. Transfer switch



3. Service entrance equipment
  4. Motors larger than 25HP
  5. Medium voltage cables
  6. Equipment rated 100A or greater.
    - a. Perform each of the following visual and electrical tests:
      - 1) Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
        - a) Test bolted connections for high resistance using one of the following:
          - (1) low-resistance ohmmeter.
          - (2) Calibrated torque wrench.
          - (3) Thermographic survey.
      - 2) Inspect compression-applied connectors for correct cable match and indentation.
      - 3) Inspect for correct identification.
      - 4) Inspect cable jacket and condition.
      - 5) 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.
      - 6) Continuity test on each conductor and cable.
      - 7) Uniform resistance of parallel conductors.
- C. Perform each of the following visual and electrical tests on all other equipment:
- 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. Test receptacles for polarity and continuity.
2. 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. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
  - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - c. 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.
- D. 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.
- E. Cables will be considered defective if they do not pass tests and inspections.

**END OF SECTION**

## SECTION 26 05 23

### CONTROL-VOLTAGE ELECTRICAL POWER CABLES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  1. Backboards.
  2. Optical fiber cabling and hardware
  3. Category 5e balanced twisted pair cable.
  4. Category 6 balanced twisted pair cable.
  5. Category 6a balanced twisted pair cable.
  6. Balanced twisted pair cabling hardware.
  7. RS-485 cabling.
  8. Low-voltage control cabling. (Unshielded)
  9. Low-voltage control cabling. (Shielded)
  10. Control-circuit conductors.
  11. Identification products.

##### 1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. 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.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Field quality-control reports.

##### 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- 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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
  - 1. Flame Travel Distance: 60 inches, (1520 mm), or less.
  - 2. Peak Optical Smoke Density: 0.5 or less.
  - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

### 2.02 CATEGORY 6A BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- B. Manufacture: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Company.
  - 2. AMP NETCONNECT.
  - 3. Belden Inc.
  - 4. Berk-Tek Leviton.
  - 5. CommScope, Inc.
  - 6. General Cable Corporation.
  - 7. Hitachi Cable America, Inc.
  - 8. Mohawk.
  - 9. Approved Substitution.
- C. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: **unshielded twisted pairs (UTP)**.
- F. Cable Rating: **Riser**.
- G. Jacket: **[White] [Gray] [Blue] [Yellow] <Insert color>** thermoplastic.

### 2.03 BALANCED TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
- B. Manufacture: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Company.
  - 2. AMP NETCONNECT.
  - 3. Belden Inc.
  - 4. Berk-Tek Leviton.
  - 5. CommScope, Inc.

6. General Cable Corporation.
  7. Hitachi Cable America, Inc.
  8. Mohawk.
  9. Approved Substitution.
- C. General Requirements for Balanced Twisted Pair Cable Hardware:
1. Comply with the performance requirements of **Category 6a**.
  2. Comply with TIA-568-C.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. Flat cable is not an acceptable option.
- D. Connecting Blocks: Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
- E. 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 balanced twisted pair cable.
  2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
- F. 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 balanced twisted pair cable.
  2. Designed to snap-in to a patch panel or faceplate.
  3. Standards:
    - a. Category 6a, unshielded balanced twisted pair cable shall comply with IEC 60603-7-41.
- G. Faceplate:
1. Two port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
  2. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
  3. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.
    - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
- H. Legend:
1. Machine printed, in the field, using adhesive-tape label.
  2. Snap-in, clear-label covers and machine-printed paper inserts.

## 2.04 LOW-VOLTAGE CONTROL CABLE (UNSHIELDED)

- A. Paired Cable: NFPA 70, Type CMG.
1. One or Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
1. One or Multi-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.

## **2.05 LOW VOLTAGE CONTROL CABLE (SHIELDED)**

- A. Standard Cable: NFPA 70, Type CM.
  - 1. Paired, one pairs, No. 16 AWG, stranded (9x29) tinned-copper conductors.
  - 2. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  - 3. PVC jacket.
  - 4. Flame Resistance: Comply with UL 1685.
  - 5. 600volt rated
  
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, one pairs, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  - 3. Plastic jacket.
  - 4. Flame Resistance: Comply with NFPA 262.
  - 5. 600vol rated.

## **2.06 CONTROL-CIRCUIT CONDUCTORS**

- A. Manufacture: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Company.
  - 2. AMP NETCONNECT.
  - 3. Belden Inc.
  - 4. Berk-Tek Leviton.
  - 5. CommScope, Inc.
  - 6. General Cable Corporation.
  - 7. Hitachi Cable America, Inc.
  - 8. Mohawk.
  - 9. Approved Substitution.
  
- B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway, Type XHHW-2, complying with UL 44 in raceway.
  
- C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway, Type XHHW-2, complying with UL 44 in raceway.
  
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway, Type XHHW-2, complying with UL 44 in raceway.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION OF RACEWAYS AND BOXES**

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
  
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
  
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
  
- D. Backboards: Install backboards with 96-inch, (2440-mm), dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

### **3.02 INSTALLATION OF CONDUCTORS AND CABLES**

- A. Comply with NECA 1 and NFPA 70.

- B. General Requirements for Cabling:
1. Comply with TIA-568-C Series of standards.
  2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
  3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
  5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
  6. 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.
  7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
  8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
  9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
  10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
  11. Support: Do not allow cables to lie on removable ceiling tiles.
  12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
  13. Provide strain relief.
  14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
  15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
- C. Balanced Twisted Pair Cable Installation:
1. Comply with TIA-568-C.2.
  2. Install termination hardware as specified in Section 27 15 13 "Communications Copper Horizontal Cabling" unless otherwise indicated.
  3. Do not untwist balanced twisted pair cables more than 1/2 inch, (12 mm), at the point of termination to maintain cable geometry.
- D. Installation of Control-Circuit Conductors:
1. Install wiring in raceways.
  2. Use insulated spade lugs for wire and cable connection to screw terminals.
  3. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- E. 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 30 inches, (760 mm), apart.
  3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.
- F. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications 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 or Circuit Rating Less Than 2 kVA: A minimum of 5 inches, (127 mm).
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches, (305 mm).
  - c. Electrical Equipment or Circuit 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 or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches, (64 mm).
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches, (150 mm).
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches, (305 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches, (75 mm).
  - c. Electrical Equipment or Circuit 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 5 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).

### **3.03 REMOVAL OF CONDUCTORS AND CABLES**

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

### **3.04 CONTROL-CIRCUIT CONDUCTORS**

- A. Minimum Conductor Sizes:
  1. Class 1 remote-control and signal circuits; No 16 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 14 AWG.

### **3.05 FIRESTOPPING**

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

### **3.06 GROUNDING**

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

### **3.07 IDENTIFICATION**

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

**END OF SECTION**



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## SECTION 26 05 26

### GROUNDING & BONDING FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section includes grounding and bonding systems and equipment, plus the following special applications:
  1. Service grounding.
  2. Underground distribution grounding.
  3. Foundation steel electrodes.
  4. Equipment grounding.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
  1. Ground rods.
  2. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
  1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
    - a. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NFPA 70B.
      - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      - 2) Include recommended testing intervals.

##### 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
- B. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- 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 UL 467 for grounding and bonding materials and equipment.

## **PART 2 PRODUCTS**

### **2.01 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.

### **2.02 CONDUCTORS**

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 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.
- C. 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.

### **2.03 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. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

### **2.04 GROUNDING ELECTRODES**

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m).

### **2.05 GROUNDING WELLS**

- A. Polymer Concrete ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.
- B. Manufacturers: Equipment from the following manufactures and which meet these specifications will be accepted:
  - 1. Christy Concrete Products, FL Series
  - 2. Quazite Style PC
  - 3. Highline Products

## **PART 3 EXECUTION**

### **3.01 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. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 24 inches (600 mm) below grade.
- C. 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.
- D. 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.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### **3.02 GROUNDING AT THE SERVICE**

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus in the main service entrance equipment. Install a main bonding jumper between the neutral and ground buses.
- B. Provide required NEC service grounds per NEC 225, 230, and 250. At a minimum at each separate building electrical service panel, provide a ground connection to the water service, building steel (if accessible), building rebar (if accessible during construction), and at a minimum on exterior ground rod. Provide additional grounding where shown on the drawings.
- C. Provide a code required electrical service grounding system at each separate building's electrical service.

### **3.03 GROUNDING SEPARATELY DERIVED SYSTEMS**

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator. The ground connection shall be terminated at the ground bus in the electrical room.
- B. Transformer: Each low-voltage transformer shall have its neutral connection on the secondary side connected directly to the ground bus located in the main electrical service equipment.

### **3.04 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS**

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-

shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

- C. Pad-Mounted Transformers and Switches: Meet requirements of utility, and at a minimum install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

### 3.05 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
- C. 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.
- D. Water Heater, Heat-Tracing, and Antifrost 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.
- E. 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.
- F. 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.
- G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- H. Metallic Fences: Comply with requirements of IEEE C2.
  - 1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
  - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
  - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

### 3.06 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. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Grounding Test Wells: Ground rod driven through bottom of grounding well.
  - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
  - 2. Install inside asphalt, and paved areas.
  - 3. Install riser ring and cover flush with surface.
  - 4. Place 9 inches crushed rock in bottom of each well.
  - 5. Ground rod shall extend up 6 inches into ground well.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. 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.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
  - 1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
  - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

### 3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- 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. 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.
  - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  - 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. 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.
  - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
  - 5. Substations and Pad-Mounted Equipment: 5 ohms.
- G. 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

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  1. Steel slotted support systems.
  2. Nonmetallic slotted support systems.
  3. Conduit and cable support devices.
  4. Support for conductors in vertical conduit.
  5. Structural steel for fabricated supports and restraints.
  6. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
  7. Fabricated metal equipment support assemblies.
- B. Related Requirements:

##### 1.03 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For the following:
  1. Steel slotted support systems.
  2. Nonmetallic slotted support systems.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

##### 1.06 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.



- D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

## **PART 2 PRODUCTS**

### **2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Preformed steel 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. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. B-line.
    - c. CADDY.
    - d. Flex-Strut, Inc.
    - e. G-Strut.
    - f. GThomas & Betts Corporation.
    - g. Approved Substitution.
  2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Material for Channel, Fittings, and Accessories: Galvanized steel or Stainless steel, Type 316.
  4. Channel Width: Selected for applicable load criteria.
  5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. 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. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. B-line.
    - c. Fabco Plastics Wholesale Limited.
    - d. G-Strut.
    - e. Approved Substitution.
  2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Channel Width: Selected for applicable load criteria.
  4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
  5. Fitting and Accessory Materials: Same as those for channels and angles except metal items may be stainless steel.
  6. Rated Strength: Selected to suit applicable load criteria.
  7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Conduit and Cable Support Devices: Steel and malleable-iron, or stainless steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored 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.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

- F. 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.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  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 F3125/F3125M, Grade A325, (Grade A325M).
  6. Toggle Bolts: Stainless-steel springhead type.
  7. Hanger Rods: Threaded steel.

## **PART 3 EXECUTION**

### **3.01 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:
1. NECA 1.
  2. NECA 101
  3. NECA 111.
- B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch, (6 mm), in diameter.
- E. 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.
1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

### **3.02 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Non-metallic channel shall be used in the chemical rooms. All other spaces shall use galvanized steel channel.
- C. 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).
- D. 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. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 or Spring-tension clamps.
  6. To Light Steel: Sheet metal screws.
  7. 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.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

### **3.03 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

### **3.04 CONCRETE BASES**

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
  1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### **3.05 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

**END OF SECTION**

## SECTION 26 05 33

### RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  1. Metal conduits and fittings.
  2. Nonmetallic conduits and fittings.
  3. Metal wireways and auxiliary gutters.
  4. Nonmetal wireways and auxiliary gutters.
  5. Boxes, enclosures, and cabinets.
  6. Handholes and boxes for exterior underground cabling.

##### 1.03 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. IMC: Intermediate Metal Conduit.
- C. RAC: Rigid Aluminum Conduit.
- D. RMC: Rigid Metal Conduit.
- E. GRC: Galvanized Rigid Steel Conduit.
- F. PVC-GRC: PVC Coated Galvanized Rigid Steel Conduit.
- G. FMC: Flexible Metal Conduit.
- H. LFMC: Liquid Tight Flexible Metal Conduit.
- I. RNC: Rigid non-metallic conduit.

##### 1.04 SUBMITTALS

- A. Product Data: For surface raceways, hinged-cover enclosures, and cabinets.

#### PART 2 PRODUCTS

##### 2.01 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
  1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
    - a. AFC Cable Systems.
    - b. Allied Tube & Conduit.
    - c. Anamet Electrical, Inc.
    - d. Calconduit.
    - e. Electri-Flex Company.

- f. FSR, Inc.
  - g. Killark.
  - h. Korkap.
  - i. NEC, Inc.
  - j. Opti-Com Manufacturing Network, Inc. (OMNI)
  - k. O-Z/Gedney.
  - l. Patriot Aluminum Products, LLC.
  - m. Perma-Cote.
  - n. Picoma Industries, Inc.
  - o. Plasti-Bond.
  - p. Approved Substitution.
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.
    - a. Metallic zinc applied by hot-dipped galvanizing or electro-galvanizing.
    - b. Threads galvanized after cutting.
    - c. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
  4. RAC: Not Allowed.
  5. IMC: Comply with ANSI C80.6 and UL 1242.
  6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - a. Comply with NEMA RN 1.
    - b. Coating Thickness: 0.040 inch, (1 mm), minimum, Polyvinyl Chloride Exterior Coating:
      - 1) Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
      - 2) The bond between the PVC Coating and the conduit surface: Greater than tensile strength of the coating.
    - c. Nominal 0.020 inch, (.5 mm), minimum urethane interior coating.
    - d. Urethane coating on threads.
    - e. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
  7. EMT: Not Allowed
  8. FMC: Flexible metal conduit: Not Allowed.
  9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
    - a. Flexible steel conduit with PVC jacket and complying with UL 360.
    - b. Core formed of continuous, spiral wound, hot-dipped galvanized steel with successive convolutions securely interlocked.
    - c. Extruded PVC outer jacket positively locked to the steel core.
    - d. Liquid and vaportight.
- B. Metal Fittings:
1. Comply with NEMA FB 1 and UL 514B.
  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. Fittings, General: Listed and labeled for type of conduit, location, and use.
  4. 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.
  5. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, (1 mm), with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC, GRC, or RAC: 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.

## 2.02 NONMETALLIC CONDUITS AND FITTINGS

- A. Nonmetallic Conduit:
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
    - a. AFC Cable Systems.
    - b. Anamet Electrical, Inc.
    - c. Arnco Corporation.

- d. CANTEX Inc.
  - e. CertainTeed Corporation.
  - f. Champion Fiberglass, Inc.
  - g. Condux International, Inc.
  - h. Electri-Flex Company
  - i. FRE Composites.
  - j. Kraloy.
  - k. Lamson & Sessions.
  - l. Niedax Inc.
  - m. RACO; Hubbell.
  - n. Thomas & Betts Corporation.
  - o. Approved Substitution.
2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. RNC: Type EPC-40-PVC, Type EPC-80-PVC.
    - a. Complying with NEMA TC 2 and UL 651 unless otherwise indicated.
    - b. Polyvinyl-chloride (PVC) plastic compound.
    - c. Rated for direct sunlight exposure where installed exposed.
    - d. Fire retardant and low smoke emission.
    - e. Suitable for use with 90 Degree C wire.
  4. LFNC: Comply with UL 1660.
- B. Nonmetallic Fittings:
1. Fittings, General: Listed and labeled for type of conduit, location, and use.
  2. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
  3. Fittings for LFNC: Comply with UL 514B.
  4. Solvents and Adhesives: As recommended by conduit manufacturer.

### 2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufactures: Subject to compliance with on for the following:
1. Cooper B-Line, Inc.
  2. Hoffman.
  3. Mono-system, Inc.
  4. Square D.
  5. Anamet Electrical, Inc.
  6. Approved Substitution.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4, Type 12, as required by the installation, 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 or Flanged-and-gasketed type depending on the installation.
- E. Finish: Manufacturer's standard enamel finish.
- F. Not permitted without submittal and prior approval by Engineer.

### 2.04 BOXES, ENCLOSURES, AND CABINETS

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. Crouse-Hinds.
  - c. EGS/Appleton Electric.

- d. Erickson Electrical Equipment Company.
  - e. FSR, Inc.
  - f. Hoffman.
  - g. Hubbell.
  - h. Kraloy.
  - i. Milbank Manufacturing Company.
  - j. MonoSystems, Inc.
  - k. Oldcastle Enclosure Solutions.
  - l. O-Z/Gedney.
  - m. Plasti-Bond.
  - n. Approved Substitution.
- 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. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
  - D. 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.
  - E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
  - F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
  - G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
  - H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
  - I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 4, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
    - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
    - 2. Nonmetallic Enclosures: Fiberglass.
    - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
    - 4. Metal barriers to separate wiring of different systems and voltage.
    - 5. Accessory feet where required for freestanding equipment.
  - J. Cabinets:
    - 1. NEMA 250, Type 1, Type 4, Type 3R to match environment 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. Metal barriers to separate wiring of different systems and voltage.
    - 4. Accessory feet where required for freestanding equipment.

## **2.05 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING**

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Manufacture: Subject to compliance by one of the following:
    - a. Armorcast Projects Company.
    - b. Carson Industries LLC.
    - c. NewBasis
    - d. Oldcastle precast, Inc.
    - e. Quazite: Hubbell Power Systems, Inc.
    - f. Synertech Moulded Products
  - 2. Standard: Comply with SCTE 77.
  - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 6. Cover Legend: As called for in the drawings.
  - 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  - 8. Handholes 12 Inches Wide by 24 Inches Long, (300 mm Wide by 600 mm Long), and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## **PART 3 EXECUTION**

### **3.01 RACEWAY APPLICATION**

- A. Area classifications are defined on the drawings. See drawings for specific area classification requirements.
- B. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC or PVC-Coated GRC.
  - 2. Concealed Conduit, Aboveground: GRC or PVC-Coated GRC.
  - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried. Schedule 80 PVC under roadways.
    - a. Provide transition to GRC, or PVC-Coated GRC for elbow and riser out of ground.
  - 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, Type 4X, Type 7.
- C. Indoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed: GRC, PVC-Coated GRC.
  - 2. Concealed in Ceilings and Interior Walls and Partitions in general purpose areas, (i.e. non-corrosive, non-classified, dry atmosphere): GRC.
  - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 4. Damp, Humid or Wet Locations: GRC, PVC-Coated GRC.
  - 5. Chemical Rooms: RAC, RNC type EPC-80-PVC, PVC-Coated GRC.
  - 6. Boxes and Enclosures:
    - a. Indoors, dry locations: NEMA 250, Type 1 or Type 12.
    - b. Damp or wet locations: NEMA 250, Type 3R or Type 4 stainless steel.
    - c. Corrosive Areas: Type 4X.
- D. Minimum Raceway Size: 3/4-inch, (21-mm), trade size.
- E. Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings. 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 compression steel 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.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

### 3.02 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. Do not fasten conduits onto the bottom side of a metal deck roof.
- C. Keep raceways at least 6 inches, (150 mm), away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Complete raceway installation before starting conductor installation.
- 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. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- H. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches, (300 mm), of enclosures to which attached.
- J. Raceways 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 raceways to reinforcement at maximum 10-foot, (3-m), intervals.
  2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  3. Arrange raceways to keep a minimum of 1 inch, (25 mm), of concrete cover in all directions.
  4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- 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. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. 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.

- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. 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.
- Q. 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.
- R. 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.
- 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. Conduit extending from interior to exterior of building.
  - 4. Conduit extending into pressurized duct and equipment.
  - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- V. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, (17 deg C), and that has straight-run length that exceeds 25 feet, (7.6 m). Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F, (55 deg C), and that has straight-run length that exceeds 100 feet, (30 m).
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F, (70 deg C), temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F, (86 deg C) temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F, (70 deg C), temperature change.
    - d. Attics: 135 deg F, (75 deg C), temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F, (0.06 mm per meter of length of straight run per deg C), of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F, (0.0115 mm per meter of length of straight run per deg C), of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches, (915 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.
- X. 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 center of box unless otherwise indicated.
- Y. 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 raintight connection between boxes and cover plates or supported equipment and box.
- Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- AA. Locate boxes so that cover or plate will not span different building finishes.
- BB. 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.
- CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

### 3.03 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches, (150 mm), in nominal diameter.
  - 2. Install backfill as specified in Section 31 20 00 "Earth Moving."
  - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches, (300 mm), of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
  - 4. Install manufactured rigid steel conduit elbows below grade for stub-ups at poles and equipment and at building entrances through floor. Transition to rigid steel conduit at elbow for riser above ground. **Rigid steel shall be used for all exposed piping above ground, non-metallic conduit is not acceptable.**
    - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches, (75 mm), of concrete for a minimum of 12 inches, (300 mm), on each side of the coupling.
    - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches, (1500 mm), from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
  - 5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

### 3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch, (12.5-mm), sieve to No. 4, (4.75-mm), sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch, (25 mm), above finished grade.

D. Install handholes with bottom below frost line.

### **3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

### **3.06 CONDUIT PENETRATIONS IN CHEMICAL ROOM WALLS**

A. Provide a conduit (LB, T, C, etc) directly on the outside of the chemical room (non-chemical space side). Fill inside of conduit with plumbers putty or silicone to stop the transference of chemical vapors.

### **3.07 FIRESTOPPING**

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

### **3.08 PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**

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## SECTION 26 05 44

### SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.
- B. Related Requirements:
  - 1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product

#### PART 2 PRODUCTS

##### 2.01 SLEEVES

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.
- C. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- D. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- E. Sleeves for Rectangular Openings:
  - 1. Material: Galvanized sheet steel.
  - 2. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches, and with no side larger than 16 inches, (400 mm), thickness shall be 0.052 inch,
    - b. For sleeve cross-section rectangle perimeter 50 inches, or more and one or more sides larger than 16 inches, (400 mm), thickness shall be 0.138 inch.

##### 2.02 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
  - 1. Eaton Link-Seal

### 2.03 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

### 2.04 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

### 3.01 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.
    - 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. 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.
- D. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using **[steel]** **[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.
- F. 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.

### 3.02 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 waterstop 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.

**END OF SECTION**



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## SECTION 26 05 53

### IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  1. Color and legend requirements for raceways, conductors, and warning labels and signs.
  2. Labels.
  3. Bands and tubes.
  4. Tapes and stencils.
  5. Tags.
  6. Signs.
  7. Cable ties.
  8. Paint for identification.
  9. Fasteners for labels and signs.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

##### 1.04 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

##### 1.05 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## **PART 2 PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Comply with NFPA 70.
- B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- C. Comply with ANSI Z535.4 for safety signs and labels.

### **2.02 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 Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
  - 1. Color shall be factory applied, or field applied for sizes larger than No. 6 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 240-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
  - 4. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 5. Color for Neutral: White for 240V and below, Gray for greater than 240V.
  - 6. Color for Equipment Grounds: Green.
  - 7. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
  - 1. Black letters on an orange field.
  - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES, (915 MM)."
  - 3. Arc Flash Label: "WARNING" for equipment with less than 40 cal/cm<sup>2</sup> incident energy and "DANGER" for equipment with greater than 40cal/cm<sup>2</sup> incident energy levels. Include the following information: Incident energy level at working distance, working distance, arc flash boundary, voltage level with covers removed, limited and restricted approach boundaries, date of survey and location.

- F. Equipment Identification Labels:
1. Black letters on a white field.
  2. For service equipment, include the following information:
    - a. Nominal system voltage.
    - b. Available fault current at the service overprotection devices based on the available fault current at the service equipment.
    - c. The clearing time of service overcurrent protective devices based on the fault current at the service equipment.
    - d. The date the label was applied.
  3. **<Insert specific requirements for equipment to be labeled, such as transformers, panelboards, etc.>**

### 2.03 LABELS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Champion America.
  3. emedco.
  4. Grafoplast Wire Markers.
  5. Helermann Tyton.
  6. LEM Products, Inc.
  7. Marking Services, Inc.
  8. Industrial Safety Solutions.
  9. Approved Substitution.
- B. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- C. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- D. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-, (0.08-mm-), thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag or printer manufacturer.
- E. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-, (0.08-mm-), thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches, (37 by 150 mm), for raceway and conductors.
    - b. 3-1/2 by 5 inches, (76 by 127 mm), for equipment.
    - c. As required by authorities having jurisdiction.

### 2.04 BANDS AND TUBES

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Helermann Tyton.
  3. Approved Substitution.
- B. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches, (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F, (93 deg C). Comply with UL 224.

## 2.05 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. 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.
- C. Tape and Stencil: 4-inch-, (100-mm-), wide black stripes on 10-inch, (250-mm), centers placed diagonally over orange background and are 12 inches, (300 mm), wide. Stop stripes at legends.
- D. Floor Marking Tape: 2-inch-, (50-mm-), wide, 5-mil, (0.125-mm), pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- E. Underground-Line Warning Tape:
  - 1. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  - 2. Color and Printing:
    - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
    - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
  - 3. Tag: Conductive:
    - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    - b. Overall Thickness: 5 mils.
    - c. Foil Core Thickness: 0.35 mil.
    - d. Weight: 28 lb/1000 sq. ft.
    - e. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

## 2.06 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch, thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:
  - 1. Polyester Tags: 0.015 inch, thick, with corrosion-resistant grommet and cable tie for attachment.
  - 2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag or printer manufacturer.

## 2.07 SIGNS

- A. Baked-Enamel Signs:
  - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 2. 1/4-inch, grommets in corners for mounting.
  - 3. Nominal Size: 7 by 10 inches.

- B. Metal-Backed Butyrate Signs:
  1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch, galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
  2. 1/4-inch, grommets in corners for mounting.
  3. Nominal Size: 10 by 14 inches.
- C. Laminated Acrylic or Melamine Plastic Signs:
  1. Engraved legend.
  2. Thickness:
    - a. For signs larger than 20 sq. in., 1/8 inch, thick.
    - b. Engraved legend with black letters on white face.
    - c. Punched or drilled for mechanical fasteners with 1/4-inch, grommets in corners for mounting or framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.08 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F.
  5. Color: Black.

## 2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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

### 3.01 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.

### 3.02 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: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot, maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall. Tape shall be conductive unless otherwise identified on drawings.
- J. Cable Ties: General purpose, for attaching tags, except as listed below:
  1. Outdoors: UV-stabilized nylon.
  2. In Spaces Handling Environmental Air: Plenum rated.

### **3.03 IDENTIFICATION SCHEDULE**

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  1. Emergency Power.
  2. Power.
  3. UPS.
- B. 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.
- C. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color coding conductor tape to identify the phase.
  1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes or self-adhesive labels with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
  - 1. Comply with 29 CFR 1910.145.
  - 2. Identify system voltage with black letters on an orange background.
  - 3. Apply to exterior of door, cover, or other access.
  - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
- N. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- O. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- P. Receptacles: Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- Q. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
  - 1. Indoor Equipment: Self-adhesive engraved laminated acrylic or melamine label.
  - 2. Outdoor Equipment: Engraved laminated acrylic or melamine label.



3. Equipment to Be Labeled:
- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
  - b. Enclosures and electrical cabinets.
  - c. Access doors and panels for concealed electrical items.
  - d. Switchgear.
  - e. Switchboards.
  - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
  - g. Substations.
  - h. Emergency system boxes and enclosures.
  - i. Motor-control centers.
  - j. Enclosed switches.
  - k. Enclosed circuit breakers.
  - l. Enclosed controllers.
  - m. Variable-speed controllers.
  - n. Push-button stations.
  - o. Power-transfer equipment.
  - p. Contactors.
  - q. Remote-controlled switches, dimmer modules, and control devices.
  - r. Battery-inverter units.
  - s. Battery racks.
  - t. Power-generating units.
  - u. Monitoring and control equipment.
  - v. UPS equipment.

**END OF SECTION**

## SECTION 26 09 23

### LIGHTING CONTROL DEVICES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Time switches.
  - 2. Photoelectric switches.
  - 3. Standalone daylight-harvesting switching and dimming controls.
  - 4. Indoor occupancy and vacancy sensors.
  - 5. Switchbox-mounted occupancy sensors.
  - 6. Digital timer light switches.
  - 7. High-bay occupancy sensors.
  - 8. Extreme temperature occupancy sensors.
  - 9. Outdoor motion sensors.
  - 10. Lighting contactors.
  - 11. Emergency shunt relays.
- B. Related Requirements:
  - 1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Show installation details for the following:
    - a. Occupancy sensors.
    - b. Vacancy sensors.
  - 2. Interconnection diagrams showing field-installed wiring.
  - 3. Include diagrams for power, signal, and control wiring.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and elevations, 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 equipment will be attached.
  - 3. Items penetrating finished ceiling, including the following:
    - a. Luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Control modules.
    - g. <Insert item>.

- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's warranties.

### **1.05 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.

### **1.06 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Faulty operation of lighting control software.
    - b. Faulty operation of lighting control devices.
  - 2. Warranty Period: one year(s) from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 TIME SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Industries, Inc.
  - 2. Intermatic, Inc.
  - 3. Invensys Controls.
  - 4. Leviton Manufacturing Co., Inc.
  - 5. NSi Industries LLC.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
  - 1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
  - 2. Contact Configuration: DPDT.
  - 3. Contact Rating: 30-A inductive or resistive, 277-V ac.
  - 4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
  - 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
  - 6. Astronomic Time: All channels.
  - 7. Automatic daylight savings time changeover.
  - 8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

### **2.02 DIGITAL ROOM LIGHTING LOAD CONTROLLER (0-10V DIMMING)**

- 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
11. Manual override and LED indication for each load
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/0-10V Dimming Enhanced Room Controllers shall include:
- 1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
  - 2. Built in real time current monitoring
  - 3. One, two or three relays configurations
  - 4. Smart 250 mA switching power supply
  - 5. Four RJ-45 DLM local network ports. Provide integral strain relief
  - 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 (LMRC-110 series and 210 series).
  - 7. WattStopper product numbers: LMRC-211, LPMC-212, LPMC-213, or equivalent product.

### **2.03 DIGITAL LIGHTING LOAD CONTROLLER CEILING AND WALL MOUNT 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. 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 (only one required per project).
  - 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.
  - 8. Manual override of controlled loads.

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. Ceiling: WattStopper product numbers: LMPC, or equivalent product.
  - F. Wall: WattStopper product numbers: LMDX, or equivalent product.

## 2.04 DIGITAL LIGHTING LOAD CONTROLLER DIMMING WALL SWITCH

- A. Low voltage momentary pushbutton switch. 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.
  6. WattStopper product numbers: LMDM-101, or equivalent product.

## 2.05 LINE-VOLTAGE OCCUPANCY SENSOR CEILING MOUNT

- A. 120/277 VAC
- B. PIR and ultrasonic dual rated with adjustable sensitivity.
- C. 5, 10, 15, 20 and 30 minute time delays.
- D. Built in light level sensor.
- E. 360 degree Fresnel lens.
- F. UL listed.
- G. Wattstopper DT355, or equivalent product.

## 2.06 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. For switchbox-mounted occupancy sensors that are not connected to a BAS or lighting control system, see Section 262726 "Wiring Devices."
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Industries, Inc.
  - 2. Hubbell Building Automation, Inc.
  - 3. Leviton Manufacturing Co., Inc.
  - 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
  - 5. Lutron Electronics Co., Inc.
  - 6. NSi Industries LLC.
  - 7. Sensor Switch, Inc.
- C. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
  - 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
  - 4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.
- D. Wall-Switch Sensor Tag WS1:
  - 1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
  - 2. Sensing Technology: Dual technology - PIR and ultrasonic.
  - 3. Switch Type: SP, manual "on," automatic "off."
  - 4. Capable of controlling load in three-way application.
  - 5. Voltage: Dual voltage - 120 and 277 V.
  - 6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
  - 7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
  - 8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
  - 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
  - 10. Color: White.
  - 11. Faceplate: Color matched to switch.

## 2.07 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allen-Bradley/Rockwell Automation.
  - 2. ASCO: a brand of Vertiv.
  - 3. Eaton.
  - 4. General Electric Company.
- B. Description: Electrically operated and electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
  - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
  - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  - 3. Enclosure: Comply with NEMA 250.
  - 4. Provide with control and pilot devices as indicated on drawings, matching the NEMA type specified for the enclosure.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. 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.

### 3.03 CONTACTOR INSTALLATION

- A. Comply with NECA 1.
- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

### 3.04 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.



### **3.05 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### **3.06 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
  - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

### **3.07 DEMONSTRATION**

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
- B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

**END OF SECTION**

## SECTION 26 22 13

### LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

##### 1.03 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
  - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
  - 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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  - 3. Include diagrams for power, signal, and control wiring.

##### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

##### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
  - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical inc.: Cutler-Hammer Products.
  - 2. General Electric Company.
  - 3. Siemens Energy and Automation, Inc.
  - 4. Schneider Electric: Square D Company.
  - 5. MGM.
  - 6. Approved Substitution.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

### 2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
  - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
  - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
  - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

### 2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70 and list and label as complying with UL 1561 for transformers greater than 10 kVA.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
  - 1. One leg per phase.
  - 2. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
  - 1. Coil Material: Copper.
  - 2. Internal Coil Connections: Brazed or pressure type.
  - 3. Terminal Connections: Bolted.
- D. Enclosure: Ventilated for 10 kVA and above, totally enclosed, non-ventilated for 9 kVA and below unless indicated otherwise on the drawings.
  - 1. NEMA 250, **Type 2**: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
  - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
  - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
  - 4. Finish: Comply with NEMA 250.
    - a. Finish Color: **Gray**, weather-resistant enamel.
- E. Taps for Transformers 3 kVA and Smaller: None.
- F. Taps for Transformers 5 to 24 kVA: One 5 percent tap FCAN and one 5 percent tap FCBN.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps FCAN and two 2.5 percent taps FCBN.
- H. Insulation Class, Smaller than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

- I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- K. Wall Brackets: Manufacturer's standard brackets.
- L. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
  - 1. 9 kVA and less: 40 dBA.
  - 2. 10 to 30 kVA: 45 dBA.
  - 3. 31 to 50 kVA: 45 dBA.
  - 4. 51 to 150 kVA: 50 dBA.
  - 5. 151 to 300 kVA: 55 dBA.
  - 6. 301 to 500 kVA: 60 dBA.
  - 7. 501 to 700 kVA: 62 dBA.
  - 8. 701 to 1000 kVA: 64 dBA.

## **2.04 IDENTIFICATION**

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

## **2.05 SOURCE QUALITY CONTROL**

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
  - 1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
  - 2. Ratio tests at rated voltage connections and at all tap connections.
  - 3. Phase relation and polarity tests at rated voltage connections.
  - 4. No load losses, and excitation current and rated voltage at rated voltage connections.
  - 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
  - 6. Applied and induced tensile tests.
  - 7. Regulation and efficiency at rated load and voltage.
  - 8. Insulation-Resistance Tests:
    - a. High voltage to ground.
    - b. Low voltage to ground.
    - c. High-voltage to low-voltage.
  - 9. Temperature tests.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located.

### 3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Wall mount transformers rated 10kVA and below using manufacturer's standard wall brackets, unless indicated otherwise on the drawings.
- C. Install transformers greater than 10kVA level and plumb on a concrete base with vibration-dampening supports unless indicated otherwise on the drawings. Locate transformers away from corners and not parallel to adjacent wall surface.
  - 1. Anchor floor-mounted transformers according to manufacturer's written instructions.
  - 2. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases.
- D. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- E. Remove shipping bolts, blocking, and wedges.

### 3.03 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. 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.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

### 3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
  - 1. Visual and Mechanical Inspection.
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, and grounding.
    - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    - d. Verify the unit is clean.
    - e. Perform specific inspections and mechanical tests recommended by manufacturer.
    - f. Verify that as-left tap connections are as specified.
    - g. Verify the presence of surge arresters and that their ratings are as specified.
  - 2. Electrical Tests:
    - a. Measure resistance at each winding, tap, and bolted connection.
    - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

- C. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, and grounding.
    - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    - d. Verify the unit is clean.
    - e. Perform specific inspections and mechanical tests recommended by manufacturer.
    - f. Verify that as-left tap connections are as specified.
    - g. Verify the presence of surge arresters and that their ratings are as specified.
  2. Electrical Tests:
    - a. Measure resistance at each winding, tap, and bolted connection.
    - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    - c. Perform power-factor or dissipation-factor tests on all windings.
    - d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    - e. Perform an excitation-current test on each phase.
    - f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
    - g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### **3.05 ADJUSTING**

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

### **3.06 CLEANING**

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

**END OF SECTION**

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## SECTION 26 24 16

### PANELBOARDS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Load centers.
  - 4. Electronic-grade panelboards.

##### 1.03 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, 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. Include dimensioned plans, elevations, sections, and details.
  - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
  - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
  - 4. Detail bus configuration, current, and voltage ratings.
  - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 7. Include wiring diagrams for power, signal, and control wiring.



## **1.05 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 01 78 23 "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

## **1.06 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 for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

## **1.07 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

## **1.08 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 where not stored in a controlled environment.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

## **1.09 FIELD CONDITIONS**

- A. Environmental Limitations:
  - 1. Do not deliver or install indoor rated 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.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet.
- C. 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 two 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**

### **2.01 PANELBOARD 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. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton, Cutler-Hammer.
  - 2. General Electric Company.
  - 3. Square D Company.
  - 4. Approved Substitution.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: **[Flush] [and] [Surface]**-mounted, dead-front cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  - 2. Height: 84 inches (2.13 m) maximum.
  - 3. Hinged Front Cover: Door-in-door trim with 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.
  - 4. Finishes:
    - a. Panels and Trim: 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.
    - b. Back Boxes: Galvanized steel, same finish as panels and trim.
- G. Incoming Mains:
  - 1. Location: Convertible between top and bottom, unless indicated on schedule as top or bottom.
  - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker, provide main breaker where indicated on panel schedule.
- H. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
    - 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. 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.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 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.
- 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 42,000 A rms symmetrical.

## **2.02 POWER PANELBOARDS**

- A. Panelboards: NEMA PB 1, distribution type.
- B. 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.
- C. Mains: Circuit breaker or main lugs only, as shown on the schedules.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- E. 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.

## **2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS**

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: Circuit breaker or main lugs only, as shown on the schedules.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. 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.

## **2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES**

- A. 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.
  2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
  3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
  4. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  5. Subfeed Circuit Breakers: Vertically mounted.
  6. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    - d. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
    - e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

## 2.05 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.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## PART 3 EXECUTION

### 3.01 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 NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, 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.

### 3.02 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 NEMA PB 1.1.
- D. Equipment Mounting:
  - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- F. Mount panelboard cabinet plumb and rigid without distortion of box.
- G. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- H. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
- I. 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.

- J. 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.
- K. Install filler plates in unused spaces.
- L. Where flush mounted below accessible ceilings, stub four 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade.
- M. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

### **3.03 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.
- E. 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.
- F. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- G. Provide arc flash and available arc fault current labeling on the equipment per NEC 110.16 and 110.24.

### **3.04 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.05 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.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
  - 1. Measure loads during period of normal facility operations.
  - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
  - 4. Tolerance: Maximum difference between phase loads, within a panelboard, should not exceed 20 percent.

### **3.06 PROTECTION**

- A. Temporary Heating: Where subject to condensation due to low temperatures and prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

**END OF SECTION**

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## SECTION 26 24 19

### MOTOR-CONTROL CENTERS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:
  1. Incoming main lugs and OCPDs.
  2. Feeder-tap units.
  3. Full-voltage magnetic controllers.
  4. VFDs.
  5. Surge Protection.
  6. Instrumentation and customer metering.
  7. Auxiliary devices.

##### 1.03 DEFINITIONS

- A. CPT: Control power transformer.
- B. GFCI: Ground fault circuit interrupting.
- C. LAN: Local area network.
- D. MCC: Motor-control center.
- E. MCCB: Molded-case circuit breaker.
- F. MCP: Motor-circuit protector.
- G. SPD: Surge protective device.
- H. SSRV: Solid State Reduced Voltage Starter.
- I. VFD: Variable-frequency drive.
- J. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

##### 1.04 SUBMITTALS

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
  2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.



- B. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details.
  - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Enclosure types and details.
    - d. Nameplate legends.
    - e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
    - f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
    - g. Specified optional features and accessories.
  - 2. Schematic Wiring Diagrams: For power, signal, and control wiring for each installed controller.
  - 3. Nameplate legends.
  - 4. Vertical and horizontal bus capacities.
  - 5. Features, characteristics, ratings, and factory settings of each installed unit.

### **1.05 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For MCCs, all installed devices, and components 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 Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications incorporated during construction by manufacturer, Contractor, or both.
    - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
    - c. Manufacturer's written instructions for setting field-adjustable overload relays.

### **1.06 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 two 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.

### **1.07 QUALITY ASSURANCE**

- A. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.
- C. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

### **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.
- B. Handle MCCs according to the following:
  - 1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."

2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

## 1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  1. Ambient Temperature Rating: Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C), with an average value not exceeding 95 deg F (35 deg C) over a 24-hour period.
  2. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
  3. Humidity Rating: Less than 95 percent (noncondensing).
  4. Altitude Rating: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
- B. Interruption of Existing Electrical Service or Distribution Systems: Do not interrupt electrical service to, or distribution systems within, a facility occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
  1. Notify Construction Manager and Engineer no fewer than 7 days in advance of proposed interruption of electrical service.
  2. Indicate method of providing temporary electrical service.
  3. Do not proceed with interruption of electrical service without Construction Manager's or Engineer's written permission.
  4. Comply with NFPA 70E.
  5. Coordinate service demo with construction sequence.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs, including clearances between MCCs and adjacent surfaces and other items.

## 1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate features of MCCs, installed units, and accessory devices with remote pilot devices and control circuits to which they connect.
- C. Coordinate features, accessories, and functions of each MCC, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. MCC manufacturer basis of design is Rockwell Automation:
  1. Rockwell Automation, Inc. Bulletin 2100.
  2. No substitutions allowed.
- B. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845.

### 2.02 RATINGS

- A. Nominal System Voltage: 480Y/277 V, three phase, four wire.
- B. Short-Circuit Current Rating: Fully rated, as shown on the one-line diagrams.

## 2.03 MOTOR CONTROL CENTER ENCLOSURES

- A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, **Type 1** unless otherwise indicated to comply with environmental conditions at installed location.
- B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's **standard gray** finish over a rust-inhibiting primer on treated metal surface.

## 2.04 ASSEMBLY

- A. Structure:
  - 1. Comply with UL requirements for service entrance equipment.
  - 2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
  - 3. Pull-apart terminal strips for external control connections.
- B. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners.
  - 1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
  - 2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
  - 3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- C. Owner's Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include PTs having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- D. Wiring Spaces:
  - 1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
  - 2. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.
- E. Provisions for Future:
  - 1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
  - 2. Compartments marked "spare" shall include provisions for connection to the vertical bus.
- F. Control Power:
  - 1. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 100 VA.
- G. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
  - 1. Wiring Class: NEMA ICS 18, Class II Type B.
- H. Bus:
  - 1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions.
  - 2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.

3. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with mechanical or compression connectors for outgoing conductors.
4. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.

## 2.05 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

- A. Incoming Mains Location: Bottom.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
  1. Adjustable magnetic trip setting for main circuit-breaker frame sizes 250 A up to 600A.
  2. Main breakers 600A and greater shall be electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Individually adjustable ground-fault setting and time delay for 1000 amp and larger.
    - e. Provide arc flash reduction mode (ARM):
      - 1) For each breaker 800 A or greater, provide a manual switch on the compartment door to switch the circuit breaker tripping characteristic to instantaneous with minimum pickup setting, in order to reduce the available energy at downstream equipment.
      - 2) Provide a lock feature for the ARM switch so that it may be locked in either the normal or instantaneous position.
      - 3) Provide a yellow LED indicating light when ARM switch is in instantaneous mode.
      - 4) Wire contacts on all ARM switches to a common alarm input to the power monitoring system digital meter.
  3. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
- C. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD shall be service entrance type surge protective device suitable for use as Type 1 or Type 2 device per UL1449 4th Edition, applied to the line or load side of the utility feed inside the facility.

## 2.06 FEEDER TAP UNITS

- A. MCCBs: Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250A to 600A, Electronic trip circuit breakers 800-1200A. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
  1. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response for 1000A and greater.
  3. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.

## 2.07 MAGNETIC CONTROLLERS

- A. Full-Voltage Controllers:
  - 1. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.
  - 2. Magnetic Controllers: Full voltage, across the line, electrically held.
    - a. Controller Units: Combination controllers.
    - b. Configuration: Non-reversing.
- B. Disconnects:
  - 1. MCP:
    - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
  - 2. MCCB:
    - a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    - d. NC alarm contact that operates only when MCCB has tripped.
- C. Overload Relays:
  - 1. Solid-State Overload Relays:
    - a. Switch or dial selectable for motor-running overload protection.
    - b. Sensors in each phase.
    - c. **Class 10/20 selectable** tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
  - 2. Two (2) NC isolated overload alarm contacts.
  - 3. External overload reset push button.

## 2.08 VARIABLE FREQUENCY DRIVES

- A. Application: Constant torque and variable torque as required for equipment installed.
- B. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2 and UL 508C.
  - 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.
- C. Disconnects:
  - 1. MCP:
    - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - d. NC alarm contact that operates only when MCP has tripped.

- e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  - 2. MCCB:
    - a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - e. NC alarm contact that operates only when MCCB has tripped.
  - 3. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
- 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. VFDs shall be heavy duty rated.
- F. Verify motor current requirements prior to ordering.
- G. Output Rating: Three-phase; 10 to 60 Hz for variable torque load or 10 to 66 Hz, with torque contact as speed change for constant torque loads, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- H. 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: 96 percent at 60 Hz, full load.
  - 5. Minimum Displacement Primary-Side Power Factor: 96percent under any load or speed condition.
  - 6. Overload Capability:
    - a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    - b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  - 7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
  - 8. Speed Regulation: Plus or minus 5 percent.
  - 9. Output Carrier Frequency: Field selectable.
  - 10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- I. 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 a minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
  - 1. Input transient protection by means of SPDs for three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  - 2. 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.
  - 3. Under- and overvoltage trips.
  - 4. Inverter overcurrent trips.
  - 5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFD

- overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
  7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  8. Loss-of-phase protection.
  9. Reverse-phase protection.
  10. Short-circuit protection.
  11. Motor overtemperature fault.
- K. 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.
1. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- L. Operator Station:
1. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
  2. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
  3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
    - a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
    - b. Security Access: 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.
- M. Displays:
1. Historical Logging Information and Displays:
    - a. Real-time clock with current time and date.
    - b. Running log of total power versus time.
    - c. Total run time.
    - d. Fault log, maintaining last four faults with time and date stamp for each.
  2. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including the following:
    - a. Output frequency (Hz).
    - b. Motor speed (rpm).
    - c. Motor status (running, stop, fault).
    - d. Motor current (amperes).
    - e. Motor torque (percentage).
    - f. Fault or alarming status (code).
    - g. PID feedback signal (percentage).
    - h. DC-link voltage (V dc).
    - i. Set-point frequency (Hz).
    - j. Motor output voltage (V ac).
- N. Provide with Ethernet output connection to Allen-Bradley PLC.
1. Ethernet outputs shall allow all data to be transmitted to PLC, including but not limited to:
    - a. Motor running.
    - b. Fault.
    - c. Speed input.
    - d. Speed output.
    - e. Motor current (amperes).
    - f. Motor Speed (rpm).
    - g. Voltage.
    - h. Frequency.
    - i. VFD shall be capable of receiving motor control, (start/stop) and motor speed setting input commands from the PLC via Ethernet.

- O. VFD conditioning and filtering:
  - 1. Each VFD shall be provided with input line conditioning, 5-percent line reactors minimum.
  - 2. Harmonic Distortion:
    - a. Drives shall be designed to limit the harmonic currents which are generated on the AC service and which would produce electromagnetic interference (EMI) or radio frequency interference (RFI). Individual current harmonic distortion and the total demand distortion expressed as percent of maximum demand load current shall not exceed the values specified in IEEE 519 – Recommended Practices and Requirements for Harmonic Control in Electric Power Systems, Table 10.3.
    - b. Total Harmonic Distortion (THD) shall not exceed 5 percent, and individual voltage harmonic distortion shall not exceed 3 percent per IEEE 519.
    - c. If the drives generate objectionable interference, EMI or RFI drive manufacturer shall provide the specifications for the equipment required to reduce it to acceptable levels. The VFD supplier shall have in possession filters to alleviate interference if encountered.
    - d. The Owner will provide the equipment specified by the drive manufacturer to correct the problem through a direct purchase or a Change Order to the Contract.
- P. Manufacturer:
  - 1. Allen-Bradley Powerflex 755 or approved equal.

## 2.09 CONTROLLER-MOUNTED AUXILIARY DEVICES

- A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oil-tight type.
    - a. Push Buttons: Recessed type; momentary contact unless otherwise indicated.
    - b. Pilot Lights: LED type; color as indicted on drawings, push to test.
    - c. Selector Switches: Rotary type.
- B. Elapsed-Time Meters: Heavy duty with digital readout in hours; non-resettable.
- C. Auxiliary Dry Contacts: Reversible NC/NO.
- D. Control Relays:
  - 1. Time Delay: Auxiliary and adjustable solid-state time-delay relays.
  - 2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.

## 2.10 MEASUREMENT AND CONTROL DEVICES

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
  - 1. PTs: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 3. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
  - 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, for selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker and ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  - 1. Listed or recognized by a nationally recognized testing laboratory.
  - 2. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
  - 3. Panel mounted with built-in LCD display



4. Measurement of the following values with the indicated maximum accuracy tolerances:
    - a. Phase Currents, Each Phase: Plus or minus 1 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - d. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
    - e. Power Factor: Plus or minus 2 percent.
    - f. Frequency: Plus or minus 0.5 percent.
    - g. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
  5. Ethernet IP communication to connect to Allen-Bradley PLC.
  6. Mounting: Display and control unit flush or semiflush mounted in MCC compartment door.
  7. Manufacturer: Allen-Bradley PowerMonitor 5000, with communication over Ethernet I/P.
- C. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from CPT.
- D. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- E. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.11 SURGE PROTECTION DEVICE

- A. Comply with UL 1449, 4<sup>th</sup> edition and UL 1283 5<sup>th</sup> edition. Type 1 or Type 2.
- B. Manufacturer: SPD's integral to the MCC shall be by MCC manufacturer, externally mounted SPD's shall be:
  1. ABB/Current Technology, Inc.
  2. Approved Substitution.
- C. Surge Protection Device Description: IEEE C62.41-compliant, solid-state, parallel-connected, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the MCC short-circuit rating, and with the following features and accessories:
  1. Fuses, if required, rated at 200-kA interrupting capacity.
  2. Fabrication using bolted compression lugs for internal wiring.
  3. Integral disconnect switch.
  4. Redundant suppression circuits.
  5. Redundant replaceable modules.
  6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
  7. LED indicator lights for power and protection status.
  8. Audible alarm, with silencing switch, to indicate when protection has failed.
  9. Form-C contacts rated at 5 A and 250-V ac, one NO and one NC, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  10. Four-digit, transient-event counter set to totalize transient surges.
- D. Peak Single-Impulse Surge Current Rating: 150 kA per mode/320 kA per phase.
- E. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- F. Features and Accessories:
  1. Provide protection against both transient surges under 100 microseconds and temporary overvoltages, (TOV) and swells up to 3600 cycles.
  2. Operating temperature range shall be -40 degrees Celsius +60 degrees Celsius (-40 degrees Fahrenheit to +140 degrees Fahrenheit).

3. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  4. Indicator light display for protection status.
  5. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
  6. Surge counter.
- G. Ratings:
1. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
    - a. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
    - b. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
    - c. Neutral to Ground: 1000 V for 480Y/277 V, 700 V for 208Y/120 V.
    - d. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
  2. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
    - a. Line to Neutral: 700 V.
    - b. Line to Ground: 700 V.
    - c. Neutral to Ground: 700 V.
    - d. Line to Line: 1200 V.
  3. The SPD shall provide Temporary Overvoltage (TOV) and voltage swell protection to the following:
    - a. TOV - should be capable of surviving and continue to protect critical loads against multiple TOV events (described as 200% nominal voltage by 8 milliseconds (ms)).
    - b. Swell - should be capable of protection against swells up to 180% nominal for 0.7 ohms load for greater than 3600 cycles.
  4. Minimum Single Pulse Surge Current Capacity based on ANSI/IEEE 8x20 microsecond wave shape. Surge currents shall be verified by an independent 3rd party test lab.
- H. Test system for repetitive sequential ANSI/IEEE C62.41 Category C3 waveforms. Minimum repetitive strikes of 1.2 X 50 s, 20 kilovolt (KV) open circuit voltage and 8 X 20 s, 10 kiloampere (KA) short circuit current with no more than 10% degradation of clamping voltage at the specified surge current. Service entrance units shall survive minimum exposure of 12,000 events, Panelboard units shall survive 5,000 events with no more than 10% degradation.
- I. Electrical Noise Filter: each unit shall include a high-performance EMI/RFI noise rejection filter with a maximum attenuation of 54dB at 142kHz, per MIL-STD-220B.
1. SPD shall include an EMI/RFI noise rejection filter for all L-N modes as well as a removable filter in the N-G mode.

## 2.12 SOURCE QUALITY CONTROL

- A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.
- B. VFD Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
  1. Test each VFD while connected to a motor that is comparable to that for which the VFC is rated.
  2. Verification of Performance: Rate VFDs according to operation of functions and features specified.
- C. MCCs will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.
- B. Coordinate layout and installation of MCCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Floor Mounting: Install MCCs on **4-inch (100-mm)** nominal-thickness concrete base.
  - 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.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in control circuits if not factory installed.
- F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Comply with NECA 1.

### **3.03 IDENTIFICATION**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.
  - 1. Identify field-installed conductors, interconnecting wiring, and components.
  - 2. Install required warning signs.
  - 3. Label MCC and each cubicle with engraved nameplate.
  - 4. Label each enclosure-mounted control and pilot device.
  - 5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.
- B. Provide arc flash and available arc fault current labeling on the equipment per NEC 110.16 and 110.24.

### **3.04 CONTROL WIRING INSTALLATION**

- A. Install wiring between enclosed controllers and remote devices and facility's central-control system.
- B. Bundle, train, and support wiring in enclosures.

- C. Connect selector switches and other automatic-control selection devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  - 2. Connect selector switches within enclosed controller 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.

### **3.05 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation.
  - 2. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
  - 5. Test each motor for proper phase rotation.
  - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 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 multipole enclosed controller. 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 multipole enclosed controller 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. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.
- D. MCCs will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.06 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.
- B. After startup, VFDs shall be thoroughly cleaned.
  - 1. Cleaning shall include wiping down of the enclosure and removal of all debris and dirt from the interior of the enclosure.
  - 2. Cleaning procedure shall include vacuuming the drive interior and wipe down of all exterior surfaces, utilization of compressed air for cleaning is not acceptable.

### **3.07 ADJUSTING**

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.
- B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six 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 eight 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 Construction Manager before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.
- E. Program microprocessors in VFDs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- F. Set field-adjustable circuit-breaker trip ranges.

### **3.08 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers.

**END OF SECTION**

**SECTION 26 27 13**  
**ELECTRICITY METERING**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section includes equipment for electricity metering by utility company.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
  - 1. Dimensioned plans and sections or elevation layouts.

**1.04 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.

**1.05 COORDINATION**

- A. Electrical Service Connections: Coordinate with Connexus Energy and components they furnish as follows:
  - 1. Comply with requirements of utilities providing electrical power services.
  - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.
  - 3. See Section 26 00 00 General Provisions for Electrical Systems for more information.

**PART 2 PRODUCTS**

**2.01 METER SOCKET**

- A. Meet Madison Gas and Electric Requirements.
- B. Each meter socket to have lever operated bypass.
- C. Provide lockable cover for all sockets.

**2.02 METERING CABINET**

- A. Meet Madison Gas and Electric Requirements.
- B. Internal bus rated for electrical service ampacity as shown on the construction drawings.
- C. Coordinate connections with electric utility to confirm cabinet and bussing meets metering instrumentation needs.
- D. wall-mounted or concrete pad-mounted as shown on the drawings.

- E. Lockable, NEMA 3R painted steel.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

### **3.02 IDENTIFICATION**

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
  - 2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

**END OF SECTION**

## SECTION 26 27 26

### WIRING DEVICES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  1. Standard-grade receptacles, 125 V, 20 A.
  2. GFCI receptacles, 125 V, 20 A.
  3. Toggle switches, 120/277 V, [15] [20] A.
  4. Wall plates.

##### 1.03 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- 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.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.

##### 1.04 SUBMITTALS

- A. Product Data: For each type of product.

##### 1.05 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.

#### PART 2 PRODUCTS

##### 2.01 MANUFACTURERS

- A. Products provided by one of the following manufactures:
  1. Eaton, Cooper, Crouse-Hinds.
  2. Hubbell Incorporated, Killark.
  3. Leviton Manufacturing Co. Inc.
  4. Pass & Seymour/Legrand (Pass & Seymour).
  5. Emerson, Appleton Electric
  6. Engineer approved Equal.



- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## **2.02 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 use.
- B. Comply with NFPA 70, RoHS compliant and NEMA WD 1.
- C. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.
- D. Wall Plate Color: For plastic covers, match device color.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## **2.03 STANDARD-GRADE RECEPTACLES, 125 V, 20 A**

- A. Duplex Receptacles, 125 V, 20 A:
  - 1. Description: Two pole, three wire, and self-grounding.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498 and FS W-C-596.
- B. Duplex GFCI Receptacles, 125 V, 20 A:
  - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Type: Non-feed through.
  - 4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

## **2.04 TOGGLE SWITCHES, 120/277 V, 20 A**

- A. Single-Pole Switches, 120/277 V, 20 A:
  - 1. Standards: Comply with UL 20 and FS W-S-896.
- B. Two-Pole Switches, 120/277 V, 20 A:
  - 1. Comply with UL 20 and FS W-S-896.
- C. Three-Way Switches, 120/277 V, 20 A:
  - 1. Comply with UL 20 and FS W-S-896.
- D. Four-Way Switches, 120/277 V, 20 A:
  - 1. Standards: Comply with UL 20 and FS W-S-896.

## **2.05 WALL PLATES**

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. 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.
  - 3. Material for unfinished spaced and surface mounting: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel.
  - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant die-cast aluminum with lockable cover.

## **PART 3 EXECUTION**

### **3.01 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 comply with NFPA 70, Article 300, without pigtails.
  - 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. Pigtailing 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 final completion.
  - 4. Connect devices to branch circuits using pigtails 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 pigtails 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.

### **3.02 GFCI RECEPTACLES**

- A. Install non-feed-through GFCI receptacles.

### 3.03 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### 3.04 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. 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.
- D. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.
- 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 51 19

### LED INTERIOR LIGHTING

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Interior solid-state luminaires that use LED technology.
  - 2. Lighting fixture supports.
- B. Provide luminaires as shown on the plans and per the luminaire schedule.

##### 1.03 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.

##### 1.04 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaires.
  - 4. Include emergency lighting units, including batteries and chargers.
  - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - 6. Photometric data and adjustment factors based on laboratory tests.
    - 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: For luminaires and lamps. Use same designations indicated on Drawings.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

## 1.06 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. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## 1.08 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: Five year(s) from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: **5 to 104 deg F (Minus 15 to plus 40 deg C)**.
- B. Relative Humidity: Zero to 95 percent.
- C. Altitude: Sea level to **3300 feet (1000 m)**.

### 2.02 LUMINAIRE REQUIREMENTS

- A. See fixture schedule on drawings for luminaire type and requirements.
- B. Luminaire Certifications & Compliances:
  - 1. U.L. standards: 844, 1598, 1598A.
  - 2. NEC and CEC: 4X, IP66, Class I, Division 1 and Class I, Division 2.
- 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. 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.
- E. Recessed luminaires shall comply with NEMA LE 4.
- F. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- G. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

- H. Rated lamp life of 50,000 hours minimum.
- I. Nominal operating voltage: As shown on the drawings.

## 2.03 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. Steel:
  - 1. ASTM A36/A36M for carbon structural steel.
  - 2. ASTM A568/A568M for sheet steel.
- C. Stainless Steel:
  - 1. Manufacturer's standard grade.
  - 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Diffusers and Globes:
  - 1. Acrylic Diffusers.
  - 2. Prismatic Glass Refractor.
  - 3. Polycarbonate Lens.
  - 4. Tempered Glass.
  - 5. Impact-resistant acrylic.
- H. Housings:
  - 1. Cold rolled steel housing.
  - 2. Baked white enamel finish.
  - 3. Die-Cast aluminum with anodized finish.
  - 4. Fiberglass.
- I. Exposed hardware Material: Stainless Steel.
- J. Plastic parts: High resistance to yellowing and other changes due to aging, expose to heat and UV radiation.
- K. Lenses and refractor gaskets: Use heat and aging resistant resilient gaskets to seal and cushion lenses and refractor in luminaire doors.
- L. Luminaire Finish: Manufacturers standard paint applied to factory-assembled and tested luminaire before shipping. Where indicated, match finish process and color of support materials.
- M. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
  - 1. White surfaces: 85 percent.
  - 2. Specular surfaces: 83 percent.
  - 3. Diffusing specular surfaces: 75 percent.

- N. Factory-Applied finish for aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Finish designations prefixed by AA comply with the system established by the aluminum association for designating aluminum finishes.
- O. 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.

## **2.04 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 and are assembled or installed to minimize contrast.

## **2.05 LUMINAIRE SUPPORT**

- A. Comply with requirements in Section 26 05 29 "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 A641/A641M, 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.
- F. Pendant mounting: Ceiling mounted box with 3/4-inch- diameter GRS conduit pendant.
- G. Stainless Steel chain with luminaire manufacturer furnished S.S. V-brackets for chains.

## **PART 3 EXECUTION**

### **3.01 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 luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 TEMPORARY LIGHTING**

- A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

### **3.03 INSTALLATION**

- A. Comply with NECA 1.

- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. 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 a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:
  - 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.
- F. Wall-Mounted Luminaires:
  - 1. Attached to structural members in walls, attached to a minimum 20 gauge backing plate attached to wall structural members or attached using through bolts and backing plates on either side of wall.
  - 2. Do not attach luminaires directly to gypsum board.
- G. Suspended Luminaires:
  - 1. Ceiling Mount:
    - a. Four-point pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports, length as required for mounting heights shown on the drawings.
  - 2. Pendant mount:
    - a. Ceiling mounted box with 3/4-inch- diameter GRS conduit pendant. Support outlet box vertically to building structure using approved devices.
    - b. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  - 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
  - 5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- H. 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. Retain subparagraph below if ceiling grid is not connected to building structure at four corners of the luminaire opening.
  - 4. 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.
- I. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- J. Adjust luminaires that require field adjustment or aiming.
- K. All interior luminaires to be controlled by motion detectors and timed light switches. Lights should not be wired to be manually shut off. Lights can be turned on through manual override.



### **3.04 CORROSION PREVENTION**

- A. Aluminum: do not use in contact with earth or concrete. When in direct contact with dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel conduits: comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems". In concrete foundations, wrap conduit with 0.010-inch (0.25mm) thick pipe-wrapping plastic tape with 50 percent overlap.
- C. Install conduit, boxes, fittings, and accessories which are suitable for the rating of the room environment.

### **3.05 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

### **3.06 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. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.

**END OF SECTION**

## SECTION 26 52 13

### EMERGENCY AND EXIT LIGHTING

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Emergency lighting units.
  - 2. Exit signs.
  - 3. Luminaire supports.

##### 1.03 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.

##### 1.04 SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
  - 1. Include data on features, accessories, and finishes.
  - 2. Include physical description of the unit and dimensions.
  - 3. Battery and charger for light units.
  - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
  - 5. 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.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

## 1.06 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## 1.08 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two year(s) from date of Substantial Completion.
- B. 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: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
  - 2. Warranty Period for Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: **5 to 104 deg F (Minus 15 to plus 40 deg C)**.
- B. Relative Humidity: Zero to 95 percent.
- C. Altitude: Sea level to **3300 feet (1000 m)**.

### 2.02 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. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
  - 1. Emergency Connection: Operate continuously at an output of 1100 lumens minimum 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. 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.
  4. Battery: Sealed, maintenance-free, nickel-cadmium or lead-acid type.
  5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
- F. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
1. Emergency Connection: Operate **[one]** <Insert number> **[fluorescent]** **[incandescent]** **[LED]** lamp continuously. 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. Battery: Sealed, maintenance-free, **[nickel-cadmium]** **[lead-acid]** type.
  4. Charger: Fully automatic, solid-state, constant-current type.
  5. 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 **[ballast]** **[emergency power unit]** manufacturer, whichever is less.
  6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

## 2.03 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency luminaires:
  1. See fixture schedule on drawings for luminaire type and requirements.
  2. Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
- C. Emergency Lighting Unit:
  1. See fixture schedule on drawings for luminaire type and requirements.
  2. Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
  3. Operating voltage as shown on the drawings.
  4. LED lamps.

## 2.04 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 voltage as shown on the drawings.
  2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
  3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

## 2.05 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.
- C. Housings:
1. Cold rolled steel housing.
  2. Die-cast aluminum.
  3. Fiberglass.
- D. Exposed hardware material: Stainless Steel.

## 2.06 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.

## 2.07 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, **12 gage (2.68 mm)**.

## PART 3 EXECUTION

### 3.01 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.

### 3.02 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. 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.

- D. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls.
  - 2. Do not attach luminaires directly to gypsum board.
- E. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. 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.

### **3.03 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

### **3.04 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.

### **3.05 STARTUP SERVICE**

- A. Perform startup service:
  - 1. Charge emergency power units and batteries a minimum of 1 hour and depress switch to conduct short-duration test.
  - 2. Charge emergency power units and batteries a minimum of 24 hours and conduct 90 minute discharge test.

**END OF SECTION**

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## SECTION 26 56 19

### LED EXTERIOR LIGHTING

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
  - 2. Luminaire supports.

##### 1.03 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

##### 1.04 SUBMITTALS

- A. Product Data: For each type of luminaire.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaire.
  - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - 5. Photometric data and adjustment factors based on laboratory tests.
    - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
  - 6. Wiring diagrams for power, control, and signal wiring.
  - 7. Photoelectric relays.
  - 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

##### 1.06 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.



- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.
- B. Package aluminum poles for shipping according to ASTM B 660.
- C. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

### **1.08 FIELD CONDITIONS**

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

### **1.09 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
  2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
  3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
  4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Ambient Temperature: Minus 22 to 104 deg F (Minus 30 to plus 40 deg C).
- B. Relative Humidity: Zero to 100 percent.
- C. Altitude: Sea level to 3300 feet (1000 m).

### **2.02 LUMINAIRE REQUIREMENTS**

- A. See fixture schedule on drawings for luminaire type and requirements.
- 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

- D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- E. UL Compliance: Comply with UL 1598 and listed for wet location.
- F. CRI as shown on the schedule.
- G. L70 lamp life of 50,000 hours.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Internal driver.
- J. Nominal Operating Voltage: As shown on the schedule.
- K. In-line Fusing: Separate in-line fuse for each pole mounted luminaire.
- L. Source Limitations: Obtain luminaires from single source from a single manufacturer.

### **2.03 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS**

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.
  - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
  - 2. Adjustable window slide for adjusting on-off set points.

### **2.04 MATERIALS**

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- C. Housings:
  - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
  - 2. Provide filter/breather for enclosed luminaires.
- D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located 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.

### **2.05 LUMINAIRE SUPPORT COMPONENTS**

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

## **PART 3 EXECUTION**

### **3.01 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 electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls for suitable conditions where wall mounted luminaires will be installed.
- D. Examine poles for suitable conditions where pole mounted luminaires will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 GENERAL INSTALLATION REQUIREMENTS**

- A. Comply with NECA 1.
- B. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Support luminaires without causing deflection of finished surface.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- C. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls.
- D. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- E. Coordinate layout and installation of luminaires with other construction.
- F. Adjust luminaires that require field adjustment or aiming.
- G. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

### **3.03 CORROSION PREVENTION**

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### **3.04 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

### **3.05 FIELD QUALITY CONTROL**

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

- B. 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. Verify operation of photoelectric controls.
  3. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- C. Luminaire will be considered defective if it does not pass tests and inspections.

**END OF SECTION**

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## SECTION 27 11 16

### COMMUNICATIONS RACKS, FRAMES AND ENCLOSURES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Network rack and associated equipment.

##### 1.03 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. TGB: Telecommunications grounding bus bar.
- G. TMGB: Telecommunications main grounding bus bar.

##### 1.04 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 equipment racks and cabinets.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.
- B. Shop Drawings: For communications racks, frames, and enclosures. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - 3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

## 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of Technician.
  - 2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
  - 3. Field Inspector: Currently registered by BICSI as **Technician** to perform on-site inspection.

## PART 2 PRODUCTS

### 2.01 DOUBLE HINGED WALL-MOUNT NETWORK RACK

- A. EIA-standard 19-inch open frame equipment enclosure to field mount network equipment as indicated on drawings.
- B. Front and rear access to 19-inch rack equipment through two enclosure hinges.
- C. NEMA 1 construction. All seams fully welded and ground smooth. Aluminum with black finish.
- D. Solid door without window. 16-gauge painted steel.
- E. Ground studs on door section, center section, and wall section.
- F. One set of plated, self-grounding, tapped 10-32 rack angles. EIA universal spacing standards. Include 10-32 mounting screws.
- G. Grounding kit.
- H. Receptacle: Duplex 120-volt receptacle mounted within the enclosure.
- I. Field adjustable hinge location (either side of door) for rear and front doors.
- J. Pentair (Hoffman), or equal.

### 2.02 NETWORK RACK ENCLOSURE MOUNTED POWER DISTRIBUTION UNITS (PDU)

- A. Mount inside double hinged wall-mount enclosure.
- B. Power on/off LED.
- C. External ground stud.
- D. Integral circuit protection (breaker) with reset button.
- E. Surge protection.
- F. Molded power cord with plug.
- G. Rack mounted in 1RU space.
- H. (2) front, (8) back NEMA 5-15R receptacles.
- I. Pentair DP1N19, or equal.

### 2.03 NETWORK ENCLOSURE MOUNTED SMART UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. Mount inside double hinged wall-mount enclosure.

- B. Rack mounted in 2RU space.
- C. 500kVA minimum or larger if indicated so on schedule.
- D. 97 percent efficiency at full load.
- E. (6) NEMA 5-15R receptacles.
- F. Molded power cord with plug.
- G. Maintenance free sealed lead-acid batteries with suspended electrolyte. Leak-proof.
- H. Communications and management interface ports: USB.
- I. LCD display.
- J. Form C dry contact for low battery alarm.
- K. APC Smart UPS RM SMT, or equal.

#### **2.04 NETWORK MOUNTED NETWORK SWITCH**

- A. Network switch will be provided by and mounted into the enclosure by the City of Madison.

#### **2.05 GROUND BUS**

- A. Internal to rack.
- B. Either mounted on rack backplane.

#### **2.06 NETWORK RACK MOUNTED RING CABLE MANAGER**

- A. Rack and Cabinet TGBs:
  1. Mount inside double hinged wall mount enclosure
  2. Rack mounted in 1RU space.
  3. Minimum 5 open cable ring along manager. Non-abrasive.
  4. Base material to be metal painted black.

#### **2.07 CATEGORY 6 ETHERNET CABLE**

- A. See Section 26 05 23.

#### **2.08 CATEGORY 6 ETHERNET PATCH CABLE**

- A. Factory constructed UTP patch cables to be used for connections between switches and PLCs, OITs, Network Switches, and Network Rack Patch Panels.
- B. Furnish resilient Category 6 UTP patch cables with braided wire. Molded boots with strain relief that support 1,000 unplugging cycles.
- C. Length. Custom.
- D. RJ-45 connector ends.
- E. Manufacturers: Belden, Panduit, Lucent, ADC, or approved equal.



## 2.09 LABELING

- 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.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
  - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
  - 2. Record agreements reached in meetings and distribute them to other participants.
  - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
  - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

### 3.02 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

### 3.03 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-B.
- B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA-606-B.
- D. Labels shall be machine printed. Type shall be **1/8 inch** in height.

**END OF SECTION**

## SECTION 27 13 00

### ACCESS CONTROL

#### PART 1 GENERAL

##### 1.01 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 26 - Electrical: Electrical systems and components.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Keyscan access controller enclosures, cards, software and programming. The facility has a 4-door Keyscan controller. Salvage and deliver this controller to the City.
  - 2. Project is to add a new 8-door controller, card readers, and request to exit proximity sensors.
  - 3. Power supplies for RS2 controllers and door hardware.
  - 4. Access controllers shall be incorporated into the existing access control system at City of Madison, WI.
  - 5. Network communications shall be via the City provided network connection.

##### 1.03 SOFTWARE FUNCTIONAL DESCRIPTIONS

- A. Provide all standard screens and functionality that comes with the access control software, with customizations as described herein.
- B. Provide card access assignments similar to existing screens.
- C. Provide individual door scheduling and card assignments similar to existing screens for all doors. Changes to door schedule shall push out to the devices immediately.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Diagrams for cable management system.
  - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
  - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
  - 4. Complete ACS one-line, block diagram.
  - 5. Cable Administration Drawings: As specified in "Identification" Article.
  - 6. Battery and charger calculations for central station and controllers.
- C. Product Schedules.

## 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Electronic submittal of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware.
  - 2. System installation and setup guides with data forms to plan and record options and setup decisions.
  - 3. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the SMS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the SMS.

## 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
  - 1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.
- B. Source Limitations: Access controllers and all software through one source from single manufacturer.
  - 1. **Approved supplier is Integral Building Systems (IBS), 717 Post Road, Madison, WI 53713 Phone: 608.467.9193.**
- 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, "National Electrical Code."
- E. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

## 1.07 WARRANTY

- A. Provide a three-year warranty for complete control access system components provided under this contract.

## 1.08 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
  - 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
  - 3. Outdoor Environment: NEMA 250, NEMA 250, Type 4 or Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.
  - 4. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The City of Madison currently uses a door access system that will be expanded as part of this project. This is the only acceptable product as it needs to integrate with the existing systems:
  - 1. Keyscan Access Control CA8500.

### **2.02 ENCLOSURES**

- A. NEMA 1, 18-gauge steel with gray powder-coated finish (inside and out).
- B. Built in cable management.
- C. Cabinet security lock. All cabinets keyed the same, and all cabinets keyed to match the Owner's existing cabinet keys. Owner can provide a cabinet key to contractor for matching.
- D. Metal pocket for guide storage.
- E. Enclosure size to be determined by supplier to house necessary equipment at each location. Multiple cabinets are acceptable when one cabinet cannot fit all access controllers. Size cabinet for a minimum of one future MR-52 card.
- F. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
  - 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
- G. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.
- H. Power supply with battery backup. Provide power supply which accepts 120-VAC input and outputs voltage required for system operation. Provide battery backup system to maintain operation of units for up to 24 hours under limited use conditions.
  - 1. Select and size power supply to provide the door electric strike and panic bar retraction power without the need for local power supplies at individual doors.
  - 2. Power supply and batteries may be in the RS2 controller enclosures, or in a separate wall-mount enclosure.

### **2.03 CONTROLLER BOARDS**

- A. The following controller boards are expected to be required for a complete installation. Include boards not stated if required for a complete and operable system.
  - 1. Intelligent 8-door controller for (8) strikes, (8) card readers, (8) RTE, (8) door contacts.
  - 2. digital input board with 16 inputs to monitor additional door contacts on hatches.

### **2.04 CARD READERS**

- A. Compatible with the Keyscan controllers.
- B. Mullion mount style is preferred.
- C. HID or pre-approved equal purchased through the approved supplier.

## **2.05 REQUEST TO EXIT PROXIMITY SENSORS**

- A. Motion sensing.
- B. Located above interior side of exterior doorways.
- C. Compatible with Keyscan controllers.

## **2.06 WEB BASED ACCESS CONTROL SYSTEM**

- A. All software modifications by the approved supplier.

## **2.07 APPLICATION SOFTWARE**

- A. All software modifications by the approved supplier.

## **2.08 CREDENTIAL MANAGMENT**

- A. Card creation and credential management will be handled by the Owner.
- B. Approved supplier to work with Owner and their existing credential management system to set up the initial rounds of credentials and confirm proper operation of cards and system.

## **2.09 DOOR ACCESS WIRE AND CABLE**

- A. Access control cable, plenum-CMP, 3-22AWG pairs, 4-18AWG conductors, 2-22AWG conductors, 2-22 AWG conductors.
- B. Stranded bare copper with Flamarrest (or equal) insulation.
- C. Each group of cables has overall shield and flamarrest (or equal) insulation.
- D. Overall jacket, or no overall jacket with banana peel (or equal) technology, up to door access provider.
- E. This specification based on Belden 658AFJ with overall jacket, or Belden 658AFS without overall jacket.

## **2.10 TRANSFORMERS**

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
  - 1. Record setup data for control station and workstations.
  - 2. For each Location, record setup of controller features and access requirements.
  - 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
  - 4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
  - 5. Assign action message names and compose messages.
  - 6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
  - 7. Prepare and install alarm graphic maps.
  - 8. Develop user-defined fields.
  - 9. Develop screen layout formats.
  - 10. Propose setups for guard tours and key control.
  - 11. Discuss badge layout options; design badges.
  - 12. Complete system diagnostics and operation verification.
  - 13. Prepare a specific plan for system testing, startup, and demonstration.
  - 14. Develop acceptance test concept and, on approval, develop specifics of the test.
  - 15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format **<Insert software>**.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

### 3.03 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Install cables and wiring according to requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables." Using door access wire and cable in Part 2 of this specification to each door with a strike, reader, RTE, and door contact. Doors and hatches that only contain a door contact may use 2#14 THHN.
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Install LAN cables using techniques, practices, and methods that are consistent with Category 5E rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.
- E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- F. Install end-of-line resistors at the field device location and not at the controller or panel location.

### 3.04 GROUNDING

- A. Comply with Section 26 05 26 "Grounding and Bonding for Electrical systems."

- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
  1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
  2. Bus: Mount on wall of main equipment room with standoff insulators.
  3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### **3.05 IDENTIFICATION**

- A. In addition to requirements in this article, comply with applicable requirements in Section 26 05 53 "Identification for Electrical Systems" and with TIA/EIA 606-A.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, cable and asset management software shall reflect as-built conditions.

### **3.06 SYSTEM SOFTWARE AND HARDWARE**

- A. Approved Supplier to develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved.
- B. Configure Owner's provide Central Station and Client workstations.

### **3.07 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.
- B. Tests and Inspections:
  1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 6 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
  2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery

- power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
  - D. Prepare test and inspection reports.

### **3.08 INSTALLATION AND START-UP**

- A. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions are required for start-up.
- B. Conduct a two-day demonstration of all system features and functions to Owner and Engineer.
- C. Coordinate installation and start-up scheduling with Owner and Engineer.

### **3.09 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
  1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  3. Security personnel.
  4. Hardware maintenance personnel.
  5. Corporate management.

### **3.10 ON-SITE SERVICES**

- A. In addition to other services specified, provide a competent programmer/instrumentation engineer or technician to perform the following services:
  1. Software revisions - three (3), eight (8) hour days on-site to make software revisions per Owner and Engineer direction. Days shall be non-continuous, number trips three (3).
  2. Training - 12-hours on-site to train Owner's personnel on:
    - a. Operation and maintenance of all equipment furnished.
    - b. Training shall be a maximum of 4-hours in a given day.
    - c. Computer software operation and programming including building reports, building graphics and modifying tags and database.
    - d. Training shall not include travel time to the site.
  3. Revision and training log: Provide a separate Owner Revisions log and a separate Owner training log. Log hours that are requested owner revision hours, and log official and scheduled training hours. Log shall have a owner initial block in each row to approve hours. Only hours that are logged shall count toward expenditure of the hours listed in this requirement.
- B. All on-site services shall be at times approved by Owner.
- C. At project completion, supplier shall certify in Writing that all un-used service hours will be provided at Owner's request during the first three years of operation. The remaining service hours shall be fulfilled by either a software engineer or field service technician as required by the task required by the Owner, at no cost.



### **3.11 CALL-BACK SERVICES**

- A. In addition to other services specified, provide a competent programmer/systems engineer or technician to return to the project site for two (2), non-consecutive eight (8) hour days during the first year of operations. During each trip, the supplier's representative shall be prepared to calibrate and check equipment furnished under this contract, give miscellaneous training, and make software revisions.
- B. Call-back trips shall be at times determined by the Owner.

**END OF SECTION**

**SECTION 28 23 00**  
**VIDEO SURVEILLANCE**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section includes a video surveillance system consisting of cameras with its associated equipment.

**1.03 DEFINITIONS**

- A. AGC: Automatic gain control.
- B. BNC: Bayonet Neill-Concelman - type of connector.
- C. B/W: Black and white.
- D. CCD: Charge-coupled device.
- E. FTP: File transfer protocol.
- F. IP: Internet protocol.
- G. LAN: Local area network.
- H. MPEG: Moving picture experts group.
- I. NTSC: National Television System Committee.
- J. PC: Personal computer.
- K. PTZ: Pan-tilt-zoom.
- L. RAID: Redundant array of independent disks.
- M. TCP: Transmission control protocol - connects hosts on the Internet.
- N. UPS: Uninterruptible power supply.
- O. WAN: Wide area network.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For video surveillance. 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. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
  3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
  4. UPS: Sizing calculations.
  5. Wiring Diagrams: For power, signal, and control wiring.
- C. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

### **1.05 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Product Warranty: Sample of special warranty.

### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
  1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

### **1.07 QUALITY ASSURANCE**

- A. Source Limitations: Access controllers and all software through one source from single manufacturer.
  1. Approved supplier is Integral Building Systems (IBS) 608.467.9193.
- 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 NECA 1.
- D. Comply with NFPA 70.

### **1.08 PROJECT CONDITIONS**

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
  2. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
  3. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 4 enclosures.
  4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick. Use NEMA 250, Type 4 enclosures.

5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, Type 4X enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

## 1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Three years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 SYSTEM REQUIREMENTS

- A. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
  1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits."
  2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

### 2.02 STANDARD CAMERAS

- A. Basis of design is Axis Communications Model P3267-LVE
  1. No Substitutions.
- B. Fixed Dome Color Camera: Assembled and tested as a manufactured unit, containing dome assembly, color camera, lens, and receiver/driver.
  1. Image sensor 1/ 2.8" progressive scan.
  2. Resolution: 1920x1080 (2 MP)
  3. Shutter time: 2- 1/66500 s to 2 s
  4. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
  5. With Auto AGC, manually selectable on or off.
  6. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of .1-2000000 lux, F/2.0 color, 0.06 lux, F1.8 B/W.
  7. Video compression: H.264 (MEP-4 Part 10/AVC) Baseline and Main Profile Motion JPEG.
  8. Frame rate: 25/30 fps with power line frequency 60hz.
  9. Video Streaming:
  10. Image Settings: Compression, color, brightness, sharpness, contrast, White balance, exposure control, backlight compensation, wide dynamic range - dynamic contrast, text and image overlay, mirroring of images, privacy mask. Rotation of image 0°, 90°, 180°, 270°, including corridor format exposure zones, fine tuning of low light behavior.

11. Manually selectable modes for backlight compensation or normal lighting.
12. Motion Detector: Built-in digital.
13. Power over Ethernet.
14. Lenses
  - a. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions. Day and night sensing.
  - b. Fixed Lens: With calibrated focus ring.
  - c. Minimum Horizontal view of 90 degrees.
  - d. Digital PTZ, Preset position, guard tour.
15. Onboard memory: 512 MB RAM, 128 MB Flash.
16. Camera angle adjustment: Pan  $\pm 175^\circ$ , Tilt  $70^\circ$ ,  $\pm$  rotation 180.
17. Enclosure: IP 66 and Type 4X, IK10 impact-resistant aluminum casing with transparent, polycarbonate cover and dehumidifying membrane. Encapsulated electronics, captive screws.
  - a. Outdoor unit to include removable lens visor.
18. Mounting
  - a. Provide mounting bracket for wall or ceiling mounting.

## **2.03 CAMERA-SUPPORTING EQUIPMENT**

- A. Mounting Brackets for Cameras:
  1. Pole mount bracket provided by manufacture of camera where camera is located on pole.
  2. Wall or ceiling mounting bracket by manufacturer of camera for other than pole locations.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 WIRING**

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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.
- D. For LAN connection and fiber-optic and copper communication wiring, comply with Section 26 05 23 "Control-Voltage Electrical Power cables".
- E. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

### **3.03 VIDEO SURVEILLANCE SYSTEM INSTALLATION**

- A. Pre-Install Conference
  1. Coordinate location and view of cameras with Owner prior to install.

2. Set up a meeting with Owner on site to review locations before any equipment, conduit, or wiring is installed.
  3. Mark the agreed-up locations with removable tape.
- B. Install cameras and infrared illuminators level and plumb.
  - C. Install cameras with 120-inch- minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
  - D. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
  - E. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
  - F. Avoid ground loops by making ground connections only at the control station.
    1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.
  - G. Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems."

### 3.04 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. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
  2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
    - a. Prepare equipment list described in "Informational Submittals" Article.
    - b. Verify operation of auto-iris lenses.
    - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
    - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
    - e. Set and name all preset positions; consult Owner's personnel.
    - f. Set sensitivity of motion detection.
    - g. Connect and verify responses to alarms.
    - h. Verify operation of control-station equipment.
  3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
  4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

- E. Video surveillance system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

### **3.05 ADJUSTING**

- A. 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. Tasks shall include, but are not limited to, the following:
  1. Check cable connections.
  2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
  3. Adjust all preset positions; consult Owner's personnel.
  4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
  5. Provide a written report of adjustments and recommendations.

### **3.06 CLEANING**

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

### **3.07 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

**END OF SECTION**

## SECTION 28 31 11

### DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Fire-alarm control unit.
  - 2. Manual fire-alarm boxes.
  - 3. System smoke detectors.
  - 4. Notification appliances.
  - 5. Remote annunciator.
  - 6. Addressable interface device.
  - 7. Fire alarm transceiver control unit.
  
- B. Related Requirements:
  - 1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

##### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
  
- B. Shop Drawings: For fire-alarm system.
  - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
  - 2. Include plans, elevations, sections, details, and attachments to other work.
  - 3. 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.
  - 4. Detail assembly and support requirements.
  - 5. Include voltage drop calculations for notification-appliance circuits.
  - 6. Include battery-size calculations.
  - 7. Include input/output matrix.
  - 8. 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.
  - 9. Include performance parameters and installation details for each detector.
  - 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  - 11. 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.
    - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    - b. Show field wiring required for HVAC unit shutdown on alarm.
    - c. Locate detectors according to manufacturer's written recommendations.
    - d. 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.
    - 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.

### **1.03 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
- C. Field quality-control reports.
- D. Sample warranty.

### **1.04 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 017823 "Operation and Maintenance Data," 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.
    - d. Riser diagram.
    - e. Record copy of site-specific software.
    - f. 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.
    - g. Manufacturer's required maintenance related to system warranty requirements.
    - h. Abbreviated operating instructions for mounting at fire-alarm control unit 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.

### **1.05 QUALIFIED FIRE PROTECTION ENGINEER (QFPE)**

- A. Construction shop drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to

the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings.

## **1.06 QUALITY ASSURANCE**

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).
- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
- E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

## **1.07 SPARE PARTS**

- A. Furnish the following spare parts in the manufacturers original unopened containers:
  - 1. Five complete sets of system keys.
  - 2. Two of each type of fuse required by the system.
  - 3. One manual pull station.
  - 4. Two of each type of detector installed.
  - 5. Two of each type of detector base and head installed.
  - 6. Two of each type of audible and visual alarm devices installed.
  - 7. Two of each type of addressable monitor module installed.
  - 8. Two of each type of addressable control module installed.

## **1.08 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.
  - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 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 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.

## 2.02 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Duct smoke detectors.
  - 5. Automatic sprinkler system water flow.
  
- B. Fire-alarm signal shall initiate the following actions:
  - 1. Continuously operate alarm notification appliances.
  - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
  - 3. Transmit an alarm signal to the remote alarm receiving station.
  - 4. Record events in the system memory.
  
- C. System trouble signal initiation shall be by one or more of the following devices and actions:
  - 1. Open circuits, shorts, and grounds in designated circuits.
  - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  - 3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
  - 4. Loss of primary power at fire-alarm control unit.
  - 5. Ground or a single break in internal circuits of fire-alarm control unit.
  - 6. Abnormal ac voltage at fire-alarm control unit.
  - 7. Break in standby battery circuitry.
  - 8. Failure of battery charging.
  - 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
  
- D. System Supervisory Signal Actions:
  - 1. Initiate notification appliances.
  - 2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
  - 3. After a time delay of 200 seconds transmit a trouble or supervisory signal to the remote alarm receiving station.

## 2.03 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. GE UTC Fire & Security; A United Technologies Company.
  - 2. Notifier.
  - 3. Siemens Industry, Inc.; Fire Safety Division.
  - 4. Silent Knight.
  - 5. SimplexGrinnell LP.
  - 6. Or approved equal.
  
- B. General Requirements for Fire-Alarm Control Unit:
  - 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
  - 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 unit 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, 80 characters, minimum.
  - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

- D. 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.
  
- E. 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.
  
- F. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
  
- G. 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 signals, and 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.
  
- H. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

#### **2.04 MANUAL FIRE-ALARM BOXES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. GE UTC Fire & Security; A United Technologies Company.
  2. Notifier.
  3. Siemens Industry, Inc.; Fire Safety Division.
  4. Silent Knight.
  5. SimplexGrinnell LP.
  6. Or approved equal.
  
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.
  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 unit.
  2. Station Reset: Key- or wrench-operated switch.

#### **2.05 SYSTEM SMOKE DETECTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. GE UTC Fire & Security; A United Technologies Company.
  2. Notifier.
  3. Siemens Industry, Inc.; Fire Safety Division.
  4. Silent Knight.
  5. SimplexGrinnell LP.
  6. Or approved equal.
  
- 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 unit.
  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.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
  - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 degrees F per minute.
  - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 degrees F.
  - c. Multiple levels of detection sensitivity for each sensor.
  - d. Sensitivity levels based on time of day.

## 2.06 NOTIFICATION APPLIANCES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. GE UTC Fire & Security; A United Technologies Company.
  2. Siemens Industry, Inc.; Fire Safety Division.
  3. SimplexGrinnell LP.
  4. Or approved equal.
- 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. Chimes: Vibrating type.
- D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.
- E. 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 high letters on the lens.
  1. Mounting: Wall mounted unless otherwise indicated.
  2. Flashing shall be in a temporal pattern, synchronized with other units.
  3. Strobe Leads: Factory connected to screw terminals.
  4. Mounting Faceplate: Factory finished, red.

## 2.07 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. Control Module:
  1. Operate notification devices.
  2. Operate solenoids for use in sprinkler service.

## 2.08 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
  - 1. Verification that both telephone lines are available.
  - 2. Programming device.
  - 3. LED display.
  - 4. Manual test report function and manual transmission clear indication.
  - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
  - 1. Address of the alarm-initiating device.
  - 2. Address of the supervisory signal.
  - 3. Address of the trouble-initiating device.
  - 4. Loss of ac supply.
  - 5. Loss of power.
  - 6. Low battery.
  - 7. Abnormal test signal.
  - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

## **2.09 RADIO ALARM TRANCEIVER AND ASSOCIATED EQUIPMENT**

- A. Manufacturers:
  - 1. SIG-COM DTX Series.
- B. General Requirements:
  - 1. Alarm and Trouble per zone.
  - 2. RS-232 or RS-485 serial ports.
  - 3. NEMA 1 metal enclosure, indoor.
  - 4. Narrowband FM transmission radio transmitter. Match Ft McCoy frequency.
  - 5. Battery backup, minimum 72 hours with fully configured system.
  - 6. 4 zones.
  - 7. 4 output relays.
- C. Antenna:
  - 1. SIG-COM model #IK-A. Confirm to match City of Madison frequency.
- D. Antenna Wall-Mount Kit:
  - 1. SIG-COM #IK-AW-18.
- E. Antenna Cable:
  - 1. LMR-400.
- F. Surge Protection:
  - 1. Provide antenna cable surge protector in the SIG-COM panel.

## **PART 3 EXECUTION**

### **3.01 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."
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
- C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
  - 1. Comply with requirements for seismic-restraint devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- D. Manual Fire-Alarm Boxes:
  - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
  - 2. Mount manual fire-alarm box on a background of a contrasting color.
  - 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- E. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.
- F. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- G. 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.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches 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.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

### **3.02 CONNECTIONS**

- A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches 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. Alarm-initiating connection to elevator recall system and components.
  - 5. Alarm-initiating connection to activate emergency lighting control.
  - 6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
  - 7. Supervisory connections at valve supervisory switches.
  - 8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
  - 9. Supervisory connections at elevator shunt-trip breaker.
  - 10. Supervisory connections at fire-extinguisher locations.

### **3.03 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

### **3.04 GROUNDING**

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

### **3.05 FIELD QUALITY CONTROL**

- A. Field tests shall be witnessed by Owner and Engineer.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
    - b. 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.
  - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. 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.
  - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
  - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
  - 6. 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.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- G. 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.

### **3.06 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 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.

**3.07 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

**END OF SECTION**

## SECTION 31 11 00

### CLEARING AND GRUBBING (WisDOT 201)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Removal and disposal of trees, shrubs, brush, stumps, roots, windfalls, unsound branches and other plant life.
- B. Method of Measurement:
  - 1. Area Basis:
    - a. Determine quantity by measuring staked areas to the nearest 1/20 of an acre.
    - b. All measurements will be made horizontally.
  - 2. Individual Unit Basis:
    - a. Determine quantity by field count of trees cleared or stumps grubbed:
      - 1) To be counted, trees must be at least 3 inches in diameter at a point 4-1/2 feet above the ground.
        - a) Diameter is measured circumference divided by 3.
      - 2) To be counted, stumps must be at least 3 inches in diameter at the point of cut off.
- C. Basis of Payment:
  - 1. Pruning of branches on plantings being preserved shall be considered incidental.
  - 2. Payment for acceptable quantities of clearing and grubbing shall be at the contract unit price as listed on the Bid Form. All associated work items shall be considered incidental.

##### 1.02 REFERENCES

- A. WisDOT 201 - Clearing and Grubbing

#### PART 2 PRODUCTS

Not Used

#### PART 3 EXECUTION

##### 3.01 PROTECTION

- A. Confine operations to the areas staked or trees marked for removal.
- B. Protect all trees and plant materials that are not designated for removal.
- C. Conduct all operations in a manner that will not damage or injure surrounding plant life and property.

##### 3.02 CLEARING OPERATIONS

- A. Cut and remove all designated trees, shrubs, bushes, windfalls and other vegetation.
- B. Prune and remove any low hanging or unsound branches.

##### 3.03 GRUBBING OPERATIONS

- A. Remove and dispose of designated stumps, roots and other remains.

- B. Remove stumps completely.
- C. Backfill depressions with native soils and compact.

#### **3.04 DISPOSAL OPERATIONS**

- A. Obtain all permits and pay all fees for disposal.

**END OF SECTION**

**SECTION 31 13 15**  
**SITE PREPARATION**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Protection of improvements, plants, and utilities.
  - 2. Removal and replacement of improvements.
  - 3. Location of utilities and coordination with utility companies.
  - 4. Temporary erosion control.
  - 5. Clearing and grubbing trees and vegetation.
  - 6. Topsoil salvage.
  - 7. Miscellaneous demolition.
  
- B. Related Sections:
  - 1. Section 31 25 10 - Temporary Erosion Control

**PART 2 PRODUCTS**

Not Used

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. Verify that existing plant life and features designated to remain are tagged or identified.

**3.02 PROTECTION**

- A. Protect improvements on site and on adjoining properties. Provide barricades, coverings or other types of protection as necessary to prevent damage and to safeguard against injury. Restore to original condition improvements damaged by the work or improvements that required temporary removal during construction.
  
- B. Protect existing vegetation indicated to remain against unnecessary cutting, breaking, bruising, or smothering by stockpiling excavated materials or parking of vehicles within drip line. Provide temporary fences, tree wells, barricades or guards; repair or replace trees and vegetation damaged by construction operations.
  
- C. Protect survey monuments, reference points, and bench marks from movement. Should removal be necessary, notify Engineer who will set reference stakes and give notice that monument may be removed. Owner will reset monument after construction at no cost to Contractor. Contractor shall pay cost for reestablishing monuments lost due to their negligence or failure to notify Engineer.
  
- D. No extra payment or time will be allowed for protection work that could have been suspected or anticipated by site inspection and interpretation of bidding documents prior to execution of contract.

**3.03 UTILITIES**

- A. Notify all affected utility companies of construction operations at least 3 working days before beginning work near their facilities. Locate existing utilities; provide adequate protection and support during construction operations. If uncharted or incorrectly charted piping or other utilities are encountered

during earthwork, consult Engineer immediately for directions as to procedure. Cooperate with Owner, and public and private utility companies to keep their services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

### **3.04 TEMPORARY EROSION CONTROL**

- A. Furnish, install and maintain temporary erosion or sedimentation control devices. Devices include hay bales, silt fences, sediment traps, flotation silt curtains and diversion mounds.
- B. Coordinate erosion control measures with earthwork and turf establishment operations. Complete work on a drainage area basis to prevent excessive soil erosion.
- C. Construct items in conformance with typical sections and elevation controls as shown on plans.
- D. Remove all items upon completion of contract work. Spread and shape accumulated sediment to permit natural drainage and provide for turf establishment.

### **3.05 SITE CLEARING AND GRUBBING**

- A. Remove trees, stumps, snags, shrubs, brush, heavy growths of grass, weeds and other vegetation, improvements, rubbish and debris, and obstructions that interfere with proposed construction; remove items only as necessary for completion of work.
- B. Cut brush and vegetation flush with ground. Grub out stumps, roots having a diameter of 2 inches or larger, and root clusters to a depth of least 2 feet below subgrade elevation for pavements, structures, and embankments and 6 inches below ground surface in other areas.
- C. Carefully and cleanly cut roots and branches of trees indicated to be left standing, where such roots and branches obstruct new construction. Cut back roots to a minimum of 1 foot from concrete work, paving, and structures and to a depth of not less than 2 feet below structures, foundations, and embankments.

### **3.06 TOPSOIL**

- A. Topsoil shall include all friable, fertile, organic clay loam, loam, sandy clay loam, sandy loam, or silt loam soil suitable for grass and plants, found at surface to a depth of approximately 6 to 12 inches, reasonably free of subsoil, clay lumps, stones, objects over 2 inches diameter, weeds, large roots, root clusters, and other objectionable material.
- B. Strip topsoil from project area to whatever depths encountered; prevent intermingling with underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping topsoil.
- C. Where trees and existing vegetation are indicated to remain, terminate stripping a sufficient distance from such trees to prevent damage to root system.
- D. Stockpile topsoil in storage piles in areas where designated. Construct storage piles to freely drain surface water. Cover or sprinkle water on storage piles to prevent windblown dust.

### **3.07 DEMOLITION**

- A. Remove structures, pavements and improvements within construction limits as shown and as required for construction. Saw cut bituminous and concrete pavement to provide a smooth straight joint. Remove below-grade items encountered, such as slabs and foundations that interfere with construction.

### **3.08 DEBRIS DISPOSAL**

- A. Remove debris and excess materials from site and legally dispose of it; do not burn debris or wood unless properly permitted.

**END OF SECTION**

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## SECTION 31 23 30

### EXCAVATION, BACKFILLING AND COMPACTING (WisDOT 209)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Trenching for sanitary sewers, water main, and appurtenances, including excavation, backfill, and compaction.
  - 2. Dewatering, protection of excavation and Site, existing utilities and other obstructions, and excesses and shortages of backfill.
  - 3. Excavating, filling, stockpiling, borrow, rough and finish grading, and placement of topsoil.
  - 4. Control of surface drainage.

##### 1.02 REFERENCES

- A. ASTM:
  - 1. C136 - Standard Method for Sieve Analysis of Fine and Course Aggregate
  - 2. C331 - Standard Specification for Lightweight Aggregate for Concrete Masonry Units
  - 3. D420 - Standard Guide for Investigating and Sampling Soil and Rock
  - 4. D698 - Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 5.5-pound Hammer and 12 inch Drop
  - 5. D1682 - Standard Test Methods for Breaking Load and Elongation of Textile Fabrics
  - 6. D2487 - Standard Test Methods for Classification of Soils for Engineering Purposes
  - 7. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- B. WisDOT 209 - Granular Backfill
- C. Standard Specifications for Sewer and Water Construction in Wisconsin

##### 1.03 SUBMITTALS

- A. Submit 10-pound sample of each type of fill to testing laboratory, in accordance with ASTM D420.

##### 1.04 DEFINITIONS

- A. Suitable Materials: ASTM D2487 classified as GW, GP, SP and SW.
- B. Unsuitable Materials: Roots or other organic matter, trash, debris, frozen materials and stones larger than 3 inches, and other materials classified in ASTM D2487 not defined as Suitable Materials. Person-made fills, refuse, or backfill from previous construction.
- C. Rock: Boulders measuring 1/2 cubic yard or more and materials that cannot be removed without systematic drilling and blasting, and below ground concrete or masonry structures, exceeding 1/2 cubic yard in volume. Pavements shall not be considered rock.
- D. Unstable Materials: Too wet to support utility pipe, conduit, or appurtenant structure.
- E. Topsoil: Fertile, friable, natural loam, surface soil. Free of subsoil, clay lumps, brush, weeds, litter, roots, stumps, stones larger than 1 inch in any dimension, and other extraneous or toxic matter harmful to plant growth.



## **PART 2 PRODUCTS**

### **2.01 MATERIAL**

- A. Bedding Material: WisDOT 209. Remove all partials retained on a 1-inch screen.
- B. Granular Material: WisDOT 209.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Prior to construction, inspect existing utility structures and surface features with Engineer and document condition.
- B. Verify with Engineer that permits necessary to do work are obtained.

### **3.02 PREPARATION**

- A. Have utility owners field mark utility locations and verify location of existing utilities prior to excavation.
- B. Protect surface features that are not designated to be removed.
- C. Notify utility companies of progress schedule so they can accomplish any necessary or previously agreed to relocations, removals, or supporting of lines.
- D. Implement traffic control. Place traffic warning signs.
- E. Strip off existing topsoil from within excavation limits and stockpile. Separate vegetation from salvageable topsoil and dispose of as appropriate.
- F. Notify Engineer and regulatory agencies of location of dewatering discharges and dewatering sedimentation basins.

### **3.03 UTILITY TRENCH EXCAVATION**

- A. Excavate trenches to line and grade shown on Drawings.
- B. Pipe Envelope: Trench width and initial backfill depth, as indicated on Drawings. Width at top of excavation will vary depending on soil and depth.
- C. Over-excavation below grade shall be corrected by replacing and compacting with granular material to 100 percent of Standard Proctor density.
- D. Slopes: Excavated to at least the angle of repose and as required by the Accident Prevention Division of the State Industrial Commission or OSHA, whichever is more restrictive. Brace, shore, or sheet and drain excavation to protect property and provide worker safety.
- E. Pile excavated material in a manner that will not endanger work or obstruct sidewalks, driveways, or gutters.
- F. Segregate soils in excavated material that are unsuitable for trench backfill and dispose of as specified in this Section.
- G. Dewater ground as necessary to excavate trench and install pipe. Hold ground water level to a minimum 2 feet below pipe invert.

- H. Direct surface and groundwater discharges to natural drainage channels, drains, or storm sewers. Provide energy dissipation at discharge point of dewatering wells or points. Provide dewatering sedimentation basins at discharge point of trench sump pump.
- I. Over-excavate when bottom of trench contains unstable or unsuitable material. Bring excavation up to pipe grade with compacted select granular or suitable material taken from excavation. Notify Engineer of soil conditions which may be poor bearing capacity and when organic soils are encountered. Install additional rock stabilization or geotextile fabric at direction of Engineer.
- J. Provide temporary support, remove, relocate, or reconstruct existing utilities located within trench excavation. Utility owner shall designate method employed. Use care and provide compacted fill or other stable support for utility crossings to prevent displacement, rupture, or failure.
- K. Excavate to expose existing utilities that cross in close proximity to new pipeline to determine utilities' location ahead of pipe installation to avoid grade conflict. Measure to determine utilities' location relative to new pipeline location. Engineer may order deviation from alignment, grade, and location to avoid conflict. Plan work with Engineer at preconstruction conference and coordinate activities during course of work.
- L. Install and maintain barricades, guards, and warning lights to protect persons from injury and avoid property damage.
- M. Maintain activities within limits shown on Drawings.

### **3.04 STRUCTURE EXCAVATION**

- A. Excavate to elevations and dimensions indicated, plus space required for construction operations, forming and inspection.
- B. Footings and foundation to rest on undisturbed soil, unless shown otherwise on Drawings, or required by the Engineer.
- C. Verify soil bearing capacity at base of footings exceeds 2,000 psf.

### **3.05 INITIAL BACKFILL**

- A. Bedding for sewers and structures: Shown on the Drawings.
- B. Remove ledge rock, boulders, and large stones to provide at least 6-inch clearance from pipe.
- C. Dig bell holes in pipe bedding at each joint such that pipe barrel rests continuously on bedding.
- D. Place backfill in uniform layers not to exceed 6 inches before compaction. Tamp each layer to eliminate possibility of lateral displacement and provide uniform support. Compact to a minimum of 95 percent of Standard Proctor density.
- E. Install trench dams at locations indicated.

### **3.06 FINAL BACKFILL**

- A. Backfill with suitable materials selected from excavated materials.
- B. Place backfill in uniform depth layers not to exceed 12 inches before compaction. Compact each layer before placing material for succeeding layer.
- C. Compact each layer by mechanical means. Trenches shall be compacted to a minimum of 95 percent of Standard Proctor density, except to 100 percent of Standard Proctor density in upper 3 feet of boulevard areas, shoulders, and paved surfaces. If moisture content of backfill material is greater than 3 percent above optimum moisture, compact material to minimum density of 3 pounds/cubic foot less

than Standard Proctor curve at that moisture content, except that minimum compaction shall be 85 percent of Standard Proctor density.

- D. Plastic Marking Tape: Installed 12 inches above underground electrical, telephone, gas conduits and 18 inches below finish grade, continuous along route of conduit.
- E. Excavated material not suitable or required for backfill shall be disposed of.
- F. Spread salvaged topsoil uniformly over disturbed area.
- G. Use select granular backfill within any building areas. Fill other areas with material from the Site.
- H. Fill in unsurfaced areas of more than 2 feet in depth shall be placed in maximum 2-foot lifts, and mechanically compacted.
- I. Scarify slopes receiving fill to permit new fill to bond. Allow clay, heavy loams or sandy loam soils to dry before using as fill.

### **3.07 FINISH GRADING**

- A. Finish site grading true to grade within 0.1 foot of the grade shown on Drawings.
- B. Plow, disk and drag any areas compacted by trucks, other vehicles or storage of materials to match texture of adjacent areas.
- C. Ensure a minimum of 6 inches of topsoil covers all unsurfaced areas. Fertilize, seed, and landscape according to 32 92 12 (Turf Establishment) and 32 93 00 (Exterior Plants) as shown in design drawings.

### **3.08 DEWATERING**

- A. Install dewatering equipment necessary to hold groundwater level to a minimum 2 feet below bottom of excavation.
- B. Direct surface and groundwater discharges to natural drainage channels, drains, or storm sewers. Provide energy dissipation at discharge point.
- C. Conduct dewatering operations in accordance with applicable regulations and permits.
- D. Assure proper erosion control methods.

### **3.09 COMPACTION**

- A. Compact all fill within building areas to minimum 98 percent modified proctor density (ASTM D1557).
- B. Notify Engineer minimum 48 hours prior to starting compaction that requires testing.
- C. Prior to filling in areas requiring compaction, remove all topsoil, vegetation, roots, and other organic materials. Place and compact material in 6-inch maximum lifts.

### **3.10 TOLERANCES**

- A. Trench settlements which occur in paved surfaces or yard areas during the guarantee period that are greater than 1 inch as measured by a 10-foot straight edge shall be repaired. Trench settlements of greater than 4 inches in remaining areas as measured by a 10-foot straight edge shall be repaired.

### **3.11 FIELD QUALITY CONTROL**

- A. Independent Testing Laboratory: Sample backfill materials, determine Moisture/ Density relationship (Standard Proctor), and perform Field Moisture/Density tests at locations determined by Engineer. Testing laboratory shall also perform gradation testing of Pipe Foundation Improvement and Bedding materials.
- B. Standard Proctor Tests: Performed exclusively for this Section and in accordance with ASTM D698.
- C. Field Moisture/Density Tests: Performed exclusively for this Section, 1 for every foot of lift in 200 lineal feet of excavation, and in accordance with ASTM D6938.
- D. Gradation Tests: Performed exclusively for this Section for material specified in Part 2 of this Section and in accordance with ASTM C136.

**END OF SECTION**

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## SECTION 32 11 26

### CRUSHED AGGREGATE BASE COURSE (WisDOT 305)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes construction of crushed aggregate base course on a prepared subgrade.
- B. Related Sections:
  - 1. Section 32 12 28 - Asphalt Surfacing
- C. Method of Measurement:
  - 1. Aggregate Base:
    - a. Measure by weight in tons based on the planned roadway dimensions.
    - b. Payment will be made for the proposed quantity unless dimensional changes are authorized.
- D. Basis of Payment:
  - 1. Payment for acceptable quantities of aggregate base shall be at the contract unit price as listed on the Bid Form. All associated work items shall be considered incidental.

##### 1.02 REFERENCES

- A. WisDOT 305 - Dense Graded Base

##### 1.03 SUBMITTALS

- A. Provide for each aggregate material:
  - 1. Name and location of source.
  - 2. Two sample gradations taken within the past 30 days from each potential source, delivered to Engineer at least 10 days prior to placement on the project.

##### 1.04 HANDLING AND DELIVERY

- A. Stockpile and drain aggregate removed from below water for a minimum 24 hours prior to delivery.

##### 1.05 SITE CONDITIONS

- A. Deposit aggregate only on dry, compact subgrade so that no rutting or displacement will occur under construction traffic.

#### PART 2 PRODUCTS

##### 2.01 MATERIALS

- A. Crushed Aggregate Base Course Materials: WisDOT 305.
- B. Aggregate Gradation: 1-1/4-inches.

## **PART 3 EXECUTION**

### **3.01 CONSTRUCTION REQUIREMENTS**

- A. Placing and Mixing:
  - 1. Place aggregate in layers to produce a maximum 3 inches of compacted thickness.
  - 2. With vibratory compaction, place to produce maximum 6 inches of compacted thickness.
  - 3. Deposit only the amount of aggregate that is intended to be spread and compacted during the same day.
  - 4. Add water as may be required during mixing to produce proper compaction.
- B. Spreading and Compacting:
  - 1. Mix aggregate uniformly to maintain proper gradation.
  - 2. Spread and compact each layer to the required cross section and density prior to placing a succeeding layer.
  - 3. Compact each layer to 100 percent of Standard Proctor Density.
- C. Tolerances: Construct each course to within 0.05 foot of the planned grades and staked elevations at all locations.

### **3.02 PROTECTION**

- A. Place initial surface course or otherwise protect the in-place aggregate base within 72 hours after placement.
- B. Remove and replace any portion of the material that becomes contaminated after placement.

**END OF SECTION**

## SECTION 32 12 18

### HOT MIX ASPHALT PAVEMENT (WisDOT 460)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Hot mix asphaltic pavement.
  - 2. Tack coat.
  - 3. Adjusting manhole castings.
  - 4. Adjusting valve boxes.
  
- B. Method of Measurement:
  - 1. Measurement shall be on a per ton basis based on the weight tickets supplied to Engineer.
  - 2. Weight will include the mixture of aggregate and asphalt delivered to and incorporated into the work. Asphaltic materials required for and incorporated into the mixture will not be measured separately for payment.
  - 3. Contractor shall furnish weight tickets at the time of delivery.
  - 4. Tack coat shall be measured by the gallon.
  - 5. Adjusting manhole castings and adjusting valve boxes shall be measured by the unit.
  
- C. Basis of Payment:
  - 1. Payment for asphaltic concrete pavement, measured as provided above, will be paid at the contract unit price per ton.
  - 2. Tack coat, measured as provided above, shall be paid at the contract unit price per gallon.
  - 3. Adjust manhole casting will be paid for at the contract unit price each.
  - 4. Adjust valve box will be paid for at the contract unit price each.

##### 1.02 REFERENCES

- A. WisDOT:
  - 1. 211 - Preparing the Foundation
  - 2. 305 - Dense Graded Base
  - 3. 350 - Subbase
  - 4. 450 - General Requirements for Asphaltic Pavements
  - 5. 455 - Asphaltic Materials
  - 6. 460 - Hot Mix Asphalt Pavement

##### 1.03 SUBMITTALS

- A. Submittals in accordance with Section 01 33 00 - including:
  - 1. Asphalt mix design in accordance with WisDOT Section 460.2.7.

#### PART 2 PRODUCTS

##### 2.01 MATERIALS

- A. Asphalt Binder: 2-1/2 inches of 3 LT 58-28 S.
  
- B. Asphalt Surface: 1-1/2 inches of 4 LT 58-28 S
  
- C. Asphaltic Material: PG 58-28, per WisDOT 455.2.



## **PART 3 EXECUTION**

### **3.01 APPLICATION**

- A. Construct pavement conforming to the general provisions of WisDOT 450.3.
- B. Compaction of the pavement shall be in accordance with the HMA Pavement Density Maximum Density Method of WisDOT 460.3.3.
- C. Tack coat shall be in conformance with WisDOT 455.2.

### **3.02 ADJUSTING**

- A. Adjust valve boxes, manholes, cleanouts or other appurtenances to new surface elevation. Engineer shall approve method of adjustment.

**END OF SECTION**

## SECTION 32 12 28

### ASPHALTIC SURFACING (WisDOT 465)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Asphaltic surface.
  - 2. Asphaltic curbs.
  - 3. Asphaltic flumes.
  - 4. Tack coat.
  - 5. Adjusting manhole castings.
  - 6. Adjusting valve boxes.
  
- B. Method of Measurement:
  - 1. Measurement shall be on a per ton basis based on the weight tickets supplied to Engineer.
  - 2. Weight will include the mixture of aggregate and asphalt delivered to and incorporated into the work. Asphaltic materials required for and incorporated into the mixture will not be measured separately for payment.
  - 3. Contractor shall furnish weight tickets at the time of delivery.
  - 4. Asphaltic curb shall be measured by the length in linear feet measured along the base of the curb.
  - 5. Asphaltic flumes will be measured by the area in square yards of complete and acceptable work.
  - 6. Tack coat shall be measured by the gallon.
  - 7. Adjusting manhole castings and adjusting valve boxes shall be measured by the unit.
  
- C. Basis of Payment:
  - 1. Payment for asphaltic concrete pavement, measured as provided above, will be paid at the contract unit price per ton.
  - 2. Asphaltic curbs, measured as provided above, shall be paid at the contract unit per linear foot.
  - 3. Asphaltic flumes, measured as provided above, shall be paid at the contract unit price per square yard.
  - 4. Tack coat, measured as provided above, shall be paid at the contract unit price per gallon.
  - 5. Adjust manhole casting will be paid for at the contract unit price each.
  - 6. Adjust valve box will be paid for at the contract unit price each.

##### 1.02 REFERENCES

- A. WisDOT:
  - 1. 211 - Preparing the Foundation
  - 2. 305 - Dense Graded Base
  - 3. 350 - Subbase
  - 4. 450 - General Requirements for Asphaltic Pavements
  - 5. 455 - Asphaltic Materials
  - 6. 460 - Hot Mix Asphalt Pavement
  - 7. 465 - Asphaltic Surface

##### 1.03 SUBMITTALS

- A. Submittals in accordance with Section 01 33 00 - including:
  - 1. Asphalt mix design in accordance with WisDOT Section 460.2.7.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Asphaltic Surface: 1-1/2" 4 LT 58-28 S per WisDOT 460.2.
- B. Asphaltic Material: PG 58-28, per WisDOT 455.2.

## **PART 3 EXECUTION**

### **3.01 APPLICATION**

- A. Construct pavement conforming to the general provisions of WisDOT 450.3.
- B. Construct asphaltic curb and asphaltic flumes in accordance with WisDOT 465.3.
- C. Compaction of the pavement shall be in accordance with the HMA Pavement Density Maximum Density Method of WisDOT 460.3.3.
- D. Tack coat shall be applied in conformance with WisDOT 455.3.2.

### **3.02 ADJUSTING**

- A. Adjust valve boxes, manholes, cleanouts or other appurtenances to new surface elevation. Engineer shall approve method of adjustment.

**END OF SECTION**

## SECTION 32 12 43

### POROUS FLEXIBLE PAVEMENT / REINFORCED TURF GRASS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Work Included: This Section includes providing all material, labor, tools and equipment for installation of the Geoblock®5150 porous pavement system as shown in the Contract Documents and as specified in this Section.
- B. The Geoblock®5150 porous pavement system shall be used for vegetated porous pavement.
- C. The following is not included in this Section:
  - 1. Hot Mix Asphalt Pavement (Section 32 12 18)
  - 2. Asphaltic Surfacing (32 12 28)
  - 3. Pavement Marking
  - 4. Parking Lot Marking
  - 5. Site Accessories
  - 6. Traffic Signs and Devices
- D. Related Sections:
  - 1. Section 31 11 00 - Clearing and Grubbing
  - 2. Section 31 13 15 - Site Preparation
  - 3. Section 31 23 30 - Excavation, Backfilling, and Compacting
  - 4. Section 31 25 10 - Temporary Erosion Control
  - 5. Section 32 11 26 - Crushed Aggregate Base Course
  - 6. Section 32 92 00 - Exterior Plants
  - 7. Section 32 92 12 - Turf Establishment
  - 8. Section 33 46 00 - Subdrainage
- E. Method of Measurement for Porous Flexible Pavement Mixture:
  - 1. Measure each by SF of Geoblock®5150 porous pavement system acceptably placed.
- F. Basis of Payment:
  - 1. Payment for Geoblock®5150 porous pavement system shall be at the Contract Unit Price listed on Bid Form.
  - 2. All associated Work items shall be considered incidental. Associated work items include supply and placement of required base course, geotextile, topsoil, and grass seed as shown in contract drawings.

##### 1.02 REFERENCES

- A. CBR - California Bearing Ratio Method.
- B. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- C. ASTM F1951-08 Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.
- D. American Association of State Highway and Transportation Officials (AASHTO)
- E. U.S. Green Building Council, LEED® Building Design and Construction (BD+C) version 4.0 Rating System. (LEED v4.0).

### 1.03 SYSTEM DESCRIPTION

- A. The Geoblock®5150 porous pavement system provides vehicular and pedestrian load support over grass areas, while protecting grass from harmful effects of traffic.
- B. Major Components of the Complete System include:
  - 1. Geoblock®5150 porous pavement unit
  - 2. Engineered base support soil
  - 3. Selected topsoil
  - 4. Selected vegetation
  - 5. Steel anchors (if required)
- C. Both the Geoblock®5150 porous pavement unit and base support soil (if required) work together to support imposed loading.
- D. Both the Geoblock®5150 porous pavement unit and topsoil contribute to vegetation support.

### 1.04 SUBMITTALS

- A. Submit manufacturer's shop drawings in accordance with Section 013000 including manufacturer's product data, general laying pattern and anchoring.
- B. Certificates:
  - 1. Product certificates signed by the manufacturer certifying material compliance of polyethylene used to make Geoblock®5150 porous pavement units.
  - 2. ISO Certificate certifying manufacturer's quality management system is currently registered to ISO 9001:2015 quality standards.
- C. Submit qualifications certifying installer experience in the installation of Geoblock®5150 Porous Pavement Systems.
- D. Submit qualifications of Manufacturer's field representative certifying field representative experience in the installation of Geoblock®5150 Porous Pavement Systems.
- E. No material will be considered as an equivalent to the Geoblock®5150 porous pavement unit specified herein unless it meets all requirements of this specification, without exception. Manufacturers seeking to supply equivalent material must submit records, data, independent test results, samples, certifications, and documentation deemed necessary by the Engineer to prove equivalency. The Engineer shall approve or disapprove other Manufacturers materials in accordance with the General Conditions after submission and review of provided information. All substitute materials submitted shall be subject to independent lab testing at the contractor's expense.

### 1.05 QUALITY ASSURANCE

- A. The Geoblock®5150 porous pavement unit shall be provided from a single Manufacturer for the entire project.
- B. The Manufacturer's Quality management system shall be certified and in accordance with ISO 9001:2015. Substitute materials submitted shall provide a certification that the manufacturing process is part of an ISO program. Certification is required specifically stating that their testing facility is certified and in accordance with ISO. An ISO certification for the substitute material will not be acceptable unless it is proven it pertains specifically to the Geoblock®5150 manufacturing operations.
- C. The Manufacturer shall provide certification of compliance to all applicable testing procedures and related specifications upon the customer's written request. Request for certification shall be submitted no later than the date of order placement. The Manufacturer shall have a minimum of 20 years' experience producing porous pavement systems.

- D. Pre-Installation Meeting: Prior to installation of any materials, conduct a pre-installation meeting to discuss the scope of work and review installation requirements. The pre-installation meeting shall be attended by all parties involved in the installation of the Geoblock®5150 porous pavement system.
  - 1. Manufacturer shall provide a qualified field representative on site at the start of construction to ensure the system is installed in accordance with the Contract Documents.
  - 2. Manufacturer's field representative shall have a minimum of 5 years installation experience with the specified products in the specified application.
  - 3. Manufacturer of any substitute materials to be used shall certify that a representative can meet the above criteria and will be on site for initial construction start up. Manufacturers other than the specified Geoblock®5150 porous pavement system will be required to provide proof the representative meets these qualifications.

## **1.06 PROJECT CONDITIONS**

- A. Environmental Requirements:
  - 1. Do not install during heavy rain or snowfall.
  - 2. Do not use frozen materials or materials mixed or coated with ice or frost.
  - 3. Do not build on wet or frozen subgrade or setting beds.
- B. Existing Conditions: Field-verify dimensions and assume full responsibility for their accuracy.
- C. Access: Maintain access for vehicular and pedestrian traffic.
- D. Do not store heavy equipment on the area in which porous flexible pavement will be laid as it will compact soils and reduce the soil's infiltration. Use construction barriers around site to prevent compaction.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to site in Manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and Manufacturer.
- B. The materials shall be stored in accordance with Manufacturer's instructions. The materials shall be protected from damage and out of direct sunlight.
- C. The materials shall be delivered, unloaded and installed in a manner to prevent damage.

## **1.08 WARRANTY**

- A. The Manufacturer warrants each Geoblock®5150 porous pavement unit that it ships to be free from defects in materials and workmanship at the time of manufacture. The Manufacturer's exclusive liability under this warranty or otherwise will be to furnish without charge to the original f.o.b. point a replacement for any section which proves to be defective under normal use and service during the 10-year period which begins on the date of shipment. The Manufacturer reserves the right to inspect any allegedly defective section in order to verify the defect and ascertain its cause.
- B. This warranty shall not cover defects attributable to causes or occurrences beyond the Manufacturer's control and unrelated to the manufacturing process, including, but not limited to, abuse, misuse, mishandling, neglect, improper storage, improper installation, improper alteration or improper application.
- C. In no event shall the Manufacturer be liable for any special, indirect, incidental or consequential damages for the breach of any express or implied warranty or for any other reason, including negligence, in connection with the Geoblock®5150 porous pavement system.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Presto Geosystems, PO Box 2399, Appleton, Wisconsin 54912-2399. Toll Free (800) 548-3424. Phone (920) 738-1328. Fax (920) 738-1222. E Mail info@prestogeo.com Website www.prestogeo.com.

### **2.02 GEOBLOCK®5150 POROUS PAVEMENT SYSTEM COMPONENTS**

- A. Geoblock®5150 Units:
  - 1. Base Materials:
    - a. The material shall be up to 100 percent recycled polyethylene.
    - b. The color shall range from dark shades of gray to black
    - c. The color shall remain uniform throughout all units in pallet.
    - d. The chemical resistance of the Geoblock®5150 porous pavement units shall be superior.
    - e. The Carbon Black content shall be 1.5 to 2 percent by weight, through addition of a carrier with ASTM D 1693.
  - 2. Performance Properties:
    - a. The empty unit minimum crush strength at 70 degrees F (21 degrees C) shall be 420 psi (2,900 kPa).
    - b. The sand-filled unit minimum crush strength at 70 degrees F (21 degrees C) shall be 7,058 psi (48,734 kPa).
    - c. The flexural modulus at 70 degrees F (21 degrees C) shall be 35,000 psi (240,000 kPa).
    - d. The unit minimum deflection without breakage when units supported at 40 inches (0.50 m) centers at 70 degrees F (21 degrees C) shall be 1.0 inches (25 mm).
    - e. The wall compressive strength (simulated tire area loaded) shall be 420 psi (2,900 kPa) when tested using circular plate, 6.5 inches (165 mm) in diameter, and loaded to failure.
    - f. The wall compressive strength (full Geoblock®5150 porous pavement unit loaded) shall be 138,240-pound-force (615 kN) when tested using full single unit loaded to failure via flat plate.
    - g. The equivalent elastic stiffness shall be 48,000 pound-square inches (140 N-m<sup>2</sup>) when tested using simply supported Geoblock®5150 porous pavement unit loaded to 1 inch (25 mm) deflection.
    - h. The joint shear strength shall be 20,000 pound-force (89.0 kN) when tested using direct shear of tabular connection using special apparatus.
  - 3. Dimensions:
    - a. The nominal product width shall be: 20 inches (0.5 meter).
    - b. The nominal product length shall be: 40 inches (1 meter).
    - c. The nominal product depth shall be: 2.0 inches (50 mm).
    - d. The nominal product area shall be: 5.3 feet<sup>2</sup> (0.5 m<sup>2</sup>).
    - e. The nominal product weight shall be 8.7 pounds (4.0 kg).
    - f. Each unit shall have 72 cells.
    - g. The nominal cell size shall be 3.1 inches by 3.2 inches (79 mm x 81 mm).
    - h. The top open area per unit shall be 87 percent.
    - i. The bottom open area per unit shall be 41 percent.
    - j. There shall be interlocking offset tabs on the edges of the unit.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Work of Other Trades: Prior to commencing Work, with Installer present, carefully inspect and verify that Work is complete to point where this installation may properly commence.
- B. Verify site conditions are as indicated on the drawings. Notify the Engineer if site conditions are not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.

- C. Verify layout of structure is as indicated on the drawings. Notify the Engineer if layout of structure is not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.
- D. Discrepancies: Immediately notify Engineer. Do not proceed with installation in areas of discrepancy until fully resolved.

### 3.02 PREPARATION

- A. Field Representation:
  - 1. On-site time for installation assistance by the Manufacturer's field representative shall be 1 day(s) with one trip. All travel and expense costs for Manufacturer's field representative installation assistance shall be included in the base bid price.
- B. Construct stormwater diversions around area where porous pavement is to be constructed.
  - 1. Perform prior to excavating for the reservoir course.
  - 2. Divert all stormwater around the porous pavement areas until pavement construction is complete and vegetation is established.
- C. Perform excavations for the reservoir course without allowing construction equipment at the bottom of the excavation. Do not compact the soil at the bottom of the excavation.
- D. If erosion causes accumulation of fine materials in any areas of the reservoir course excavation, these fine materials shall be removed prior to placement of geotextile.
- E. Any areas damaged by erosion, ponding, or traffic compaction shall be reworked before stone placement.
- F. Bring subgrade to the line, grade, and elevations indicated; establish and maintain. Notify Engineer for review and approval of final stake lines before construction Work is to begin.
- G. Post signs to prevent vehicles from entering the area with muddy tires. If muddy vehicle access cannot be prevented, install a temporary access road.
- H. Subgrade:
  - 1. Prepare subgrade and install porous pavement system in accordance with the Drawings and Manufacturer's instructions.
  - 2. Subgrade Preparation
    - a. Excavate and shape foundation soils as indicated on the Drawings.
    - b. Ensure foundation soil meets minimum strength requirements through proof rolling or other conventional method and is approved by the Engineer. If unacceptable foundation soils are encountered, excavate and replace with suitable quality material as directed by the Engineer.
- I. Base Preparation
  - 1. Install base as specified. Verify engineered base is installed in accordance with porous pavement system Manufacturer's instructions.
  - 2. Place engineered base as specified in the Contract Documents.
  - 3. Place engineered base open graded crushed rock having an AASHTO #5 or similar designation homogenously blended with topsoil.
    - a. Ensure aggregate portion of base is free from fines and has a known percentage void-space of 30 percent or greater when compacted.
    - b. Particle size shall range in size from 0.375 to 1.0 inch (9.5 to 25 mm).
    - c. Add and blend pulverized topsoil before placement equal to void percentage in aggregate.
    - d. Pulverized topsoil portion shall equal plus or minus 33 percent of the total volume and be added and blended to produce a homogenous mixture.
    - e. Compact the mixture to the Engineer's specifications.
  - 4. Constrain the edges of the base appropriately to prevent movement.



### 3.03 INSTALLATION OF POROUS PAVEMENT SYSTEM

- A. Install and infill Geoblock®5150 porous pavement units in accordance with porous paving system Manufacturer's instructions.
  - 1. Ensure that all adjacent hard-surfaced paving work is completed before installing the Geoblock®5150 porous pavement system.
  - 2. GEOBLOCK®5150 UNITS ARE CAPABLE OF BEARING LOAD IMMEDIATELY after placement, once fully installed and the base depth is appropriate to support the loading. Geoblock®5150 porous pavement units can be driven on with no infill necessary. No barriers are required to prevent passenger cars and trucks or construction equipment from driving on the Geoblock®5150 porous pavement units during installation.
  
- B. Installing Geoblock®5150 Units
  - 1. Place units with the square hole to the ground.
  - 2. Lay units in the following pattern:
  - 3. Standard herringbone pattern as directed by the manufacturer
  - 4. Field cut units to custom fit contours and around obstructions. Edge restraints are required to create a closed "cell" that can be infilled. Alternatively, offset the Geoblock®5150 units such that the coverage approximates the corner or curve feature. Edge restraints are required.
  - 5. Place first row of Geoblock®5150 porous pavement units against a single stationary edge, when available. If the units are placed between two perpendicular stationary edges, allow for potential thermal expansion of the units by keeping the units away from the stationary edge.
  - 6. Slide units together so interlocking tab joint is fully engaged. Units shall not protrude above desired surface elevation.
  - 7. Prevent units from shifting during installation with placement of one of the following:
    - a. Temporary wood stakes or permanent metal stakes through holes in the Geoblock®5150 units
    - b. Thread-forming tapping screws through perimeter interlocking tabs. Install 2 to 4 screws on the long side and 1 to 2 screws on the short side. Refer to the Geoblock®5150 Application and Installation Overview or consult Presto Geosystems for details.
  
- C. Infilling Geoblock®5150 Units
  - 1. Infill units with pulverized topsoil immediately after units are installed.
    - a. Runoff Coefficient is dependent upon the actual site conditions and Geoblock®5150 porous pavement system infill material.
    - b. Runoff Coefficient @ 2.5 in/hr (64 mm/hr) rainfall shall be 0-0.15.
    - c. Typical runoff coefficients range from 0 to 0.15 for sandy and clay soils, respectively.
    - d. The actual run-off coefficient shall be based on site conditions, engineering judgment and the integrated effect of the drainage area.
  - 2. Spread topsoil infill uniformly over units to a level even with the top of the cell wall.
  - 3. Use spreading methods to prevent over-compaction of cell infill.
  - 4. Overfilling the cells is not recommended since vehicular loading will cause undesirable compaction of the topsoil.
  - 5. Broom or rotary sweep the infilled surface to remove the top portion of topsoil infill from the Geoblock®5150 cells so it has a meniscus appearance. Final topsoil placement should be slightly below the level of the Geoblock®5150 cell wall.
  - 6. If final vegetation is sod, the Geoblock®5150 porous pavement units shall be under-filled by sod depth to allow room to seat or press sod into Geoblock®5150 porous pavement units.
  - 7. Topsoil: As specified in Section 329200 Manufacturers of Turfs and Grasses.

### 3.04 ABOVE GROUND, POST INSTALLATION DELINEATION

- A. Delineate the Geoblock®5150 porous pavement system above ground, after installation is complete, with one of the following methods:
  - 1. Delineation markers

### 3.05 SEED AND GRASSING

- A. Finish in accordance with Manufacturer's instructions.

- B. Seeding:
  - 1. The seed mix shall be as shown on the drawings or as specified in the Contract Documents.
  - 2. Follow good seeding, fertilizing, and watering procedures for turf establishment based on regional practices as specified in Section 32 92 12 Turf Grass Establishment.
  - 3. Seed shall conform with the requirements of the governing authority for seeding and restrictions on noxious weed seed.

### **3.06 MAINTENANCE INSTRUCTIONS**

- A. Maintain grass in accordance with manufacturer's instructions and as specified in Section 32 92 12 Turf Grass Establishment.
- B. Lawn Care: Normal turf care procedures should be followed, including de-thatching and aerating. Some equipment may slightly scar or cut the Geoblock®5150 wall structure during some operations, but will not affect overall structural integrity of the system.
- C. Snow Removal: Remove snow using one of the following basic procedures:
  - 1. Keep a metal edged plow blade a minimum of 1.0 inch (25 mm) above the surface during plowing operations, or
  - 2. Use a plow blade with a flexible rubber edge, or
  - 3. Use a plow blade with skids on the lower outside corners so the plow blade does not come in contact with the units.

**END OF SECTION**

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## SECTION 32 31 13

### CHAIN LINK FENCE

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide:
  - 1. Chain link fence.
  - 2. Fence accessories.
  
- B. Related Sections:
  - 1. Section 03 30 00 - Cast-in-Place Concrete
  - 2. Section 31 22 10 - Site Grading

##### 1.02 REFERENCES

- A. ASTM:
  - 1. A121 - Metallic Coated Carbon Steel Barbed Wire
  - 2. A123 - Hot Dip Galvanized Coatings on Iron and Steel Products
  - 3. A153 - Hot Dip Zinc Coating on Iron and Steel Hardware
  - 4. A181 - Carbon Steel Forgings for Piping
  - 5. A390 - Hot Dip Galvanized Steel Poultry Fence Fabric
  - 6. A491 - Aluminum-Coated Steel Chain Link Fence Fabric
  - 7. A780 - Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
  - 8. A817 - Metallic Coated Steel Wire for Chain Link Fence Fabric
  - 9. A824 - Metallic Coated Steel Tension Wire for Chain Link Fence
  - 10. C33 - Concrete Aggregates
  - 11. C150 - Portland Cement
  - 12. F567 - Installation of Chain Link Fence
  - 13. F626 - Fence Fittings
  - 14. F668 - PVC Coated Steel Chain Link Fence Fabric
  - 15. F900 - Industrial Swing Gates
  - 16. F1043 - Strength and Protective Coatings on Chain Link Fence Framework
  - 17. F1083 - Pipe, Steel, Hot-Dipped Galvanized Welded for Fence Structures
  - 18. F1184 - Industrial and Commercial Horizontal Slide Gates

##### 1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data, finishes, dimensions of individual components and profiles, and installation instructions for fencing, fabric, gates, and accessories.
  
- B. Shop Drawings:
  - 1. Show locations of fences, posts, rails, tension wires, details of extended posts, extension arms, hardware, and accessories.
  - 2. Indicate materials, dimensions, sizes, weights, and finishes of components.
  - 3. Include plans, elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.
  
- C. Samples: 6-inch length of fabric wire for verification and selection of PVC color.
  
- D. Product Certificates: For each type of chain-link fence and gate, signed by product manufacturer.
  
- E. Testing: Strength test results for framing per ASTM F1043.

## 1.04 QUALITY ASSURANCE

- A. Provide chain link fences as complete units by single source including necessary erection accessories, fittings, and fastenings.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering galvanize steel fencing and fabric which may be incorporated in Work include:
  1. Allied Tube and Conduit Corporation
  2. American Fence Corporation
  3. Ameristar Fence Products
  4. Anchor Fence, Inc.
  5. Cyclone Fence/United States Steel Corporation
  6. Merchants Metals, Inc. [www.merchantsmetals.com](http://www.merchantsmetals.com)
  7. Tymetal [www.tymetal.com](http://www.tymetal.com)
  8. Manufacturer of comparable products submitted in compliance with Section 01 25 13.

### 2.02 STEEL FABRIC

- A. Material: 9 gauge (0.148 inch plus 0.005 inch) finished size galvanized steel wires, 2-inch mesh, per ASTM A390.
- B. Top selvages knuckled for fabric 60-inch high and under.
- C. Coating:
  1. Color: Black
  2. PVC weatherproof coating per ASTM F668.

### 2.03 FRAMING AND ACCESSORIES

- A. Dimensions: Pipe, roll-formed, H-sections are outside dimensions, exclusive of coatings.
- B. Steel Framework: Hot-dipped galvanized steel, ASTM F1083, not less than 1.8-ounce zinc per square foot of surface.
- C. Fittings and Accessories: Galvanized, ASTM F626.
- D. End, Corner, Pull Posts: Minimum sizes and weights as follows:
  1. Up to 6 feet fabric height, 2.375-inch outside diameter steel pipe, 3.65 pounds per lineal foot, or 3.5-inch by 3.5-inch roll-formed sections, 4.85 pounds per lineal foot.
- E. Line Posts: Space 8 feet on center maximum, unless otherwise indicated, of following minimum sizes and weights:
  1. Up to 6-foot fabric height, 1.90-inch outside diameter steel pipe, 2.70 pounds per lineal foot, or 1.875-inch by 1.625-inch C-sections, 2.28 pounds per lineal foot.
- F. Top Rail:
  1. Manufacturer's longest lengths.
  2. Expansion type couplings, approximately 6 inches long, for each joint.
  3. Provide means for attaching top rail securely to each gate, corner, pull, end post.
  4. 1.66-inch outside diameter pipe, 2.27 pounds per foot, or 1.625 inch by 1.25-inch roll-formed sections, 1.35 pounds per foot.
- G. Wire Ties: 11 gage galvanized steel or 11 gage aluminum wire, to match fabric core material.

- H. Post Brace Assembly:
  1. Manufacturer's standard adjustable brace at end, gate posts, both sides of corner and pull posts
  2. Horizontal brace located at mid-height of fabric.
  3. Use same material as top rail for brace, truss to line posts with 0.375-inch diameter rod, adjustable tightener.
  
- I. Post Tops:
  1. Weathertight closure cap with loop to receive tension wire or toprail.
  2. One cap per post.
  
- J. Tension Bars:
  1. Aluminum.
  2. 1-piece lengths equal to full height of fabric, with minimum cross-section of 3/16-inch by 3/4-inch.
  3. 1 bar for each gate and end post, 2 for each corner and pull post, except where fabric integrally woven into post.
  
- K. Tension Wire:
  1. Metallic Coated Steel Wire: 0.177-inch diameter, per ASTM A824.
    - a. Type I: Aluminum coated.
    - b. Type II: Zinc-coated.
  2. Provide at:
    - a. Extended along top and bottom of fence fabric.
  
- L. Concrete:
  1. Consisting of portland cement - ASTM C150, aggregates - ASTM C33, and clean water.
  2. Mix materials to obtain concrete with minimum 28-day compressive strength of 3,000 psi using minimum 4 sacks of cement per cubic yard.
  3. 1-inch maximum size aggregate.
  4. Maximum 3-inch slump.
  5. 2 to 4 percent entrained air.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Examine areas and conditions, with installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, Site clearing, earthwork, pavement work, and other conditions affecting performance.
  1. Do not begin installation before final grading is completed, unless otherwise permitted by Engineer.
  2. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. General:
  1. Install chain-link fencing to comply with ASTM F567 and more stringent requirements specified.
  2. Install fencing on established boundary lines inside property line.
  
- B. Excavation:
  1. Drill or hand excavate (using post hole digger) holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.
  2. If not indicated on Drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but at least 4 times largest cross-section of post.
  3. Unless otherwise indicated, excavate hole depths approximately 3 inches lower than post bottom, with bottom of posts set at least 36 inches below finish grade surface.
  
- C. Setting Posts:
  1. Center and align posts in holes 3 inches above bottom of excavation.

2. Place concrete around posts, vibrate or tamp for consolidation.
  3. Check for vertical and top alignment, hold in position during placement and finishing operations.
  4. Unless otherwise indicated, extend concrete footings 2 inches above grade, trowel to crown to shed water.
- D. Top Rails:
1. Run rail continuously through post caps, bending to radius for curved runs.
  2. Provide expansion couplings as recommended by fencing manufacturer.
- E. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.
- F. Fabric:
1. Leave approximately 2 inches between finish grade and bottom selvage, unless otherwise indicated.
  2. Pull fabric taut and tie to posts, rails, tension wires.
  3. Install on security side of fence, anchor to framework so that fabric remains in tension after pulling force released.
- G. Tension Bars: Thread through or clamp to fabric 4 inches on center, secure to posts with metal bands spaced 15 inches on center.
- H. Tie Wires:
1. Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns.
  2. Bend ends of wire to minimize hazard to persons or clothing.
  3. Tie fabric to line posts, with wire ties spaced 12 inches on center.
  4. Tie fabric to rails and braces, with wire ties spaced 24 inches on center.
  5. Tie fabric to tension wires, with hog rings spaced 24 inches on center.
- I. Fasteners:
1. Install nuts for tension bands and hardware bolts on side of fence opposite fabric side.
  2. Peen ends of bolts or score threads to prevent removal of nuts.

### 3.03 CLEANING

- A. Site:
1. Do not allow accumulation of scraps, debris arising from Work of this Section.
  2. Maintain premises in neat, orderly condition.
- B. System:
1. Immediately after erection, clean field welds, bolted connections, and abraded areas.
  2. Refinish exposed or abraded areas with same material used for shop finishing to comply with SSPC-PA 1 for touching up shop-finished surfaces.
  3. Comply with ASTM A780 for repair of damaged hot dip galvanized coating.
- C. Construction Waste:
1. Minimize waste generated from construction, renovation, and demolition of buildings through detailing and specifications.
  2. Divert construction, demolition, and land clearing debris from landfill disposal.
  3. Redirect recyclable material back to the manufacturing process and reuse, recycle, and/or salvage minimum 75 percent (by weight) of construction, demolition, and land clearing waste.
- D. Packaging Waste:
1. Reduce and recycle packaging waste associated with the construction process.
  2. Encourage manufacturers to ship products using reusable, recyclable, returnable, or recycled content packaging.
  3. Reuse or return 50 percent of all packaging material, by weight, to supplier or manufacturers.

### **3.04 DEMONSTRATION**

- A. Maintenance Instructions: Manufacturer's representative to schedule and attend meeting with Owner's representative to explain:
  - 1. Maintenance and care instructions.
  - 2. Recommended maintenance program.
  - 3. Warranty requirements.

**END OF SECTION**



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## SECTION 32 91 00

### TOPSOIL PLACEMENT

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide the following:
  - 1. Subsoil preparation.
  - 2. Soil composition.
  - 3. Placement of topsoil.
  - 4. Soils Report:
    - a. Existing topsoil.
    - b. Amended topsoil.
  
- B. Related Sections:
  - 1. Section 31 22 20 - Earthwork for Building Sites
  - 2. Section 31 25 10 - Temporary Erosion Control
  - 3. Section 32 92 12 - Turf Establishment
  - 4. Section 32 93 00 - Exterior Plants
  
- C. Basis of Payment:
  - 1. Payment for acceptable quantities of select topsoil borrow shall be at the contract unit price as listed on the Bid Form.
  - 2. Associated work items shall be incidental to unit price.
  - 3. Importation of materials required for provision of topsoil is incidental to Work.

##### 1.02 SUBMITTALS

- A. Refer to Section 01 33 00.
  
- B. Quality Assurance/Control Submittals:
  - 1. Test Reports:
    - a. Provide following qualification tests and information for topsoil either imported or prepared from on-site material.
    - b. Submittal to be prepared by independent testing lab, state university soils science department, or other recognized soil physics testing laboratory to indicate that proposed material complies with specified requirements.
      - 1) Mechanical gradation analysis, ASTM D422.
      - 2) Materials qualification test.
      - 3) Recommendation for type and application rate of amendments needed to adjust topsoil to required nutrient levels for each proposed landscape operation, including, seeding, sodding, planting.
  
- C. Delay resulting from rejected submittals is Contractor's responsibility and will not be considered as basis for subsequent delay claim.

#### PART 2 PRODUCTS

##### 2.01 SOILS MATERIALS

- A. Topsoil for Irrigated Areas:
  - 1. Material consisting of fertile, friable, fine sandy loam, uniform in composition.
  - 2. Capable of sustaining vigorous plant growth.

3. Free of subsoil, stones, lumps, clods of hard earth, plants, plant roots, sticks, noxious weeds, slag, cinders, demolition debris or other extraneous matter over 1 inch in largest dimension.
4. Conforming to following chemical and physical attributes:
  - a. Allowable limits of topsoil mechanical analysis based on percent of dry weight of samples:

	Minimum Percent	Maximum Percent
No. 4 Sieve	100	---
No. 10 Sieve	80	90
No. 200 Sieve	15	25
Silt (particles 0.005-0.05 mm) <sup>(1)</sup>	10	20
Clay (particles < 0.005 mm) <sup>(1)</sup>	5	10

<sup>(1)</sup> Silt-Clay ratio: 2:1 or less

B. Topsoil for Non-Irrigated Areas:

1. Material consisting of fertile, friable, loam, uniform in composition.
2. Capable of sustaining vigorous plant growth.
3. Free of subsoil, stones, lumps, clods of hard earth, plants, plant roots, sticks, noxious weeds, slag, cinders, demolition debris or other extraneous matter over 1 inch in largest dimension.
4. Conforming to following chemical and physical attributes:
  - a. Allowable limits of topsoil mechanical analysis based on percent of dry weight of samples:

	Minimum Percent	Maximum Percent
No. 4 Sieve	100	---
No. 10 Sieve	80	90
No. 200 Sieve	40	60
Silt (particles 0.005-0.05 mm) <sup>(1)</sup>	10	40
Clay (particles < 0.005 mm) <sup>(1)</sup>	5	20

<sup>(1)</sup> Silt-Clay ratio: 2:1 or less

- b. Allowable maximum limits of mechanical analysis of sand and gravel fraction based on dry weight of total fraction sample:

	Minimum Percent	Maximum Percent
Very Fine Sand (< 0.15 mm)	0	5
Fine Sand (0.15-0.25 mm)	0	20
Coarse Sand (0.25-1.00 mm)	60	100
Very Coarse Sand (1.00-2.00 mm)	0	10
Gravel (> 2.00 mm)	0	5

<sup>(1)</sup> Silt-Clay ratio: 2:1 or less

C. Final Topsoil Nutrient Values After Amendment (if required):

1. Organic Matter: 4.0 percent minimum, 10.0 percent maximum.
2. Extractable Phosphorus: 25 parts per million by weight minimum.
3. Exchangeable Potassium: 125 parts per million by weight minimum.
4. pH: 5.5 minimum, 7.0 maximum, 6-6.5 preferred.
5. Soluble Salts: 3 mmhos/cm maximum.
6. Lead Content: Less than 400 parts per million.

D. On-site Base Mixture: To extent available, and if modified to meet requirements, select on-site material may be used as base mixture for preparation of topsoil.

E. Import supplemental materials as necessary to satisfy specified topsoil requirements.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and conditions under which topsoil preparation and placement are to be performed.
  - 1. Verify final subgrade has been established.
  - 2. Verify topsoil meets requirements of this Section and soils testing lab report identifying required amendments is completed.
  - 3. Verify compaction requirements in Section 31 22 20 have not been exceeded.
- B. Discrepancies:
  - 1. Immediately notify Engineer.
  - 2. Do not proceed in areas of discrepancy until fully resolved.
  - 3. Commencement of topsoil placement signifies acceptance of surface conditions. Do not proceed until unsatisfactory conditions have been corrected.

### **3.02 STORAGE/STOCKPILE**

- A. Stockpile location: As directed by Engineer.
- B. Stockpile topsoil/planter soil component materials in such a manner that natural drainage is not obstructed and that no off-site sediment transmission will result.
- C. Place stockpiles with maximum 2:1 sideslopes.
- D. Construct a temporary perimeter dike with gravel outlet, or fabric sediment barrier around topsoil component stockpiles.
- E. Provide temporary seeding of stockpiles within 2 days of formation of stockpile.
- F. Place mulch per Section 32 92 00.

### **3.03 PREPARATION AND PLACEMENT**

- A. Topsoil Placement Preparation:
  - 1. Provide erosion and sediment control items such as diversions, berms, dikes, waterways, sediment basins, as specified or as needed.
  - 2. Remove debris from areas to be topsoiled, including excess concrete and concrete spoils adjacent to back of curb locations, and excavation spoils.
  - 3. Eliminate uneven areas and low spots; maintain indicated grades and make changes in grade gradual by blending slopes into more level areas.
  - 4. After the areas to be topsoiled have been brought to inferred subgrade elevations, and immediately prior to dumping and spreading approved topsoil, loosen and condition the subgrade by power rototilling to a minimum depth of 8 inches to ensure removal of gross subgrade debris and bonding of the topsoil and subsoil; no substitute operations acceptable.
  - 5. After rototilling and prior to placement of the topsoil, scalp or otherwise remove all visible stones, clods of hard earth, roots, plant parts, stumps, sticks, weeds, demolition or construction debris, or any other extraneous non-earth material in excess of 1 inch in size.
- B. Topsoil Placement:
  - 1. Do not place topsoil more than 2 weeks prior to planned commencement of Project planting operations.
  - 2. Do not place wet or muddy topsoil, when subgrade is excessively wet, or in condition that may otherwise be detrimental to subsequent Work.
  - 3. Uniformly place approved topsoil material where indicated to minimum compacted depth of 6 inches on 3:1 on steeper slopes, minimum of 8 inches on flatter slopes, and at greater depths as indicated on Drawings.
  - 4. Topsoil in excess of 8 inches is acceptable and desirable if excess is available.

5. Correct irregularities in surface resulting from placement or other operations to prevent formation of depressions or water pockets.
6. Avoid excessive compaction of topsoil; refer to limits in Section 31 22 20.
7. Protect topsoiled areas from weather based erosion until planting operations commence.

**END OF SECTION**

## SECTION 32 92 12

### TURF ESTABLISHMENT

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes establishment of herbaceous ground cover on designated areas.
- B. Related Sections:
  - 1. Section 31 25 10 - Temporary Erosion Control
- C. Method of Measurement:
  - 1. Fertilizer: Measure by weight in pounds of each mixture applied.
  - 2. Seeding: Measure by the weight in pounds.
  - 3. Mulch: Measure mulch by the square yard.
  - 4. Water: Water for turf establishment will be considered incidental.
  - 5. Sodding: Measure by area sodded in square yards.
  - 6. Topsoil: Measured by loose volume (LV) in cubic yards based on vehicular measure.
  - 7. Salvaged Topsoil: Measure in square yards of the area topsoiled to the specified depth.
  - 8. Turf Establishment: Measure turf establishment by the square yard.
  - 9. Establishment of turf in Contractor staging area(s) shall be considered incidental.
  - 10. All measurements to be within the area of construction.
- D. Basis of Payment:
  - 1. Payment for acceptable quantities of turf establishment shall be at the contract unit price as listed on the Bid Form. All associated work items including but not limited to topsoil, fertilizer, seed, mulch and water shall be considered incidental.

##### 1.02 REFERENCES

- A. City of Madison Standard Specifications for Public Works Construction, current edition
  - 1. Article 207 Seeding
- B. WisDOT:
  - 1. 625 - Topsoil and Salvaged Topsoil
  - 2. 627 - Mulching
  - 3. 629 - Fertilizer and Agricultural Limestone
  - 4. 630 - Seeding
  - 5. 631 - Sodding Except 631.3.5 Watering

##### 1.03 SUBMITTALS

- A. Submit certified test report for each seed mixture.
- B. Submit certification from the grower stating the grass varieties contained in the sod.

##### 1.04 ACCEPTANCE OF WORK

- A. Turf establishment will be accepted on a total project basis.
- B. All erosion control items must also be in place and properly maintained prior to acceptance.
- C. Once accepted, Contractor is relieved of any further maintenance or repair.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Protect seed from moisture, heat, rodents, and other damage prior to use.
- B. Deliver sod to Site within 24 hours after cutting.
- C. Place sod on the same day it is delivered.
- D. Deliver fertilizer in waterproof bags showing weight, chemical analysis and name of manufacturer.

## **1.06 SCHEDULE OF WORK**

- A. Coordinate turf establishment to minimize lag time after topsoil placement.
- B. Plant seed between May 1 and September 20.
- C. Place sod between May 5 and June 10 or between August 10 and November 1.

## **1.07 MAINTENANCE**

- A. Maintain and repair all areas until acceptance.
- B. Maintain and water sod for 30 days.
- C. Contractor shall apply water as needed in accordance with the requirements of WisDOT 631.3.5.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Topsoil: WisDOT 625.2.
- B. Mulch: WisDOT 627.
- C. Fertilizer: WisDOT 629, Type B.
- D. Turf Grass Seed: WisDOT 630.2.1.5., Seed Mix 40.
- E. No-Mow Turf: City of Madison Standard Specification Article 207 Seeding, no-mow turf.
- F. Sod: WisDOT 631.

## **PART 3 EXECUTION**

### **3.01 SOIL PREPARATIONS**

- A. Remove all undesirable weeds as directed.
- B. Loosen topsoil on all areas with 2:1 slopes or flatter prior to seeding or sodding.
- C. Cultivate to a depth of 3 inches using discs or other suitable equipment.
- D. Operate equipment at right angles to direction of drainage.
- E. Fill all washouts prior to cultivation.
- F. Finish all areas to provide a smooth, moist, even-textured foundation of uniform density.

G. Approval of the Engineer is required prior to placing seed or sod.

### **3.02 CONSTRUCTION REQUIREMENTS**

A. Applying Fertilizer and Conditioners:

1. Apply fertilizer uniformly over the designated area using mechanical spreading devices.
2. Apply at a rate of 7 pounds per 1,000 square feet.
3. Apply fertilizer prior to placing sod.
4. Apply fertilizer no more than 48 hours prior to seeding.

B. Sowing Seed:

1. Apply seed mixture 40 over designated areas at a total rate of 3 pounds per 1,000 square feet.
2. Apply seed uniformly by mechanical or hydrospreading method.
3. Firm all seeded areas with a drag or cultipacker immediately after seeding and prior to mulching.

C. Placing Sod:

1. Prepare sodding areas prior to delivery of sod.
2. Place sod strips at right angles to direction of drainage.
3. Place sod strips with staggered end joints.
4. Water and roll sod immediately after placement.
5. Complete repair of sodded areas as directed within 5 days after placement.
6. Stake sod on slopes as directed by Engineer to prevent displacement.

**END OF SECTION**



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**SECTION 32 93 00**

**EXTERIOR PLANTS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Trees.
  - 2. Shrubs.
  - 3. Perennials.
  - 4. Plants and bulbs.
  - 5. Landscape accessories including, but not limited to:
    - a. Weed barrier.
    - b. Mulch.
    - c. Edging.
    - d. Wrapping.
    - e. Stakes and guys.
  
- B. Perform the following:
  - 1. Finish grading. (Section 31 23 30)
  - 2. Preparation of topsoil.
  - 3. Plant installation.
  - 4. Initial maintenance of landscape materials.
  - 5. Pruning and relocation of existing plant materials.
  
- C. Related Sections:
  - 1. Section 31 11 00 - Clearing and Grubbing
  - 2. Section 31 23 30 – Excavation, Backfilling and Compacting
  
- D. Basis of Payment:
  - 1. All materials and labor necessary for the installation of all plant material shall be measured and paid for as a unit price, listed on Bid Form.
  - 2. All materials and labor necessary for the installation of mulch in planting beds shall be measured and paid for as a unit price, listed on Bid Form. All other mulch is incidental to the Unit Price Bid of the plants.
  - 3. All materials and labor necessary for the installation of edging at planting beds shall be measured and paid for as a unit price, listed on Bid Form.
  - 4. Fertilizer, compost, protective materials, and other specified materials are incidental to the Unit Price Bid of the plants.

**1.02 REFERENCES**

- A. ANSI :
  - 1. 60.1 - American Standard for Nursery Stock
  
- B. ASTM:
  - 1. C602 - Standard for Agricultural Liming Materials
  - 2. D5268 - Standard for Topsoil Used for Landscaping Purposes
  
- C. USCC - The US Composting Council

**1.03 SUBMITTALS**

- A. Refer to Section 01 33 00.

- B. Product Data: For each type of product indicated.
- C. Samples for Verification:
  1. 5 pounds of mineral mulch in labeled plastic bag.
  2. Edging materials, accessories.
- D. Plant and Material Certifications:
  1. Certificates of inspection as required by governmental authorities.
  2. Manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials and standard products.
  3. Label data substantiating that plants, trees, shrubs and planting materials comply with specified requirements.
- E. Maintenance: Typed instructions recommending procedures to be established by Owner for maintenance of landscape work for 1 full year. Submit prior to expiration of required maintenance period.
- F. Material Test Reports: Provide for existing surface soil and imported topsoil.

#### 1.04 QUALITY ASSURANCE

- A. Qualifications:
  1. Installer: A qualified landscape installer whose work has resulted in successful plant and tree establishment.
  2. Field Supervisor: Installer to maintain an experienced full-time supervisor on Site when planting is in progress.
  3. Soil Testing Laboratory: An independent laboratory recognized by the State DOA.
- B. Trees, Shrubs and Plants:
  1. Measurements:
    - a. Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position.
    - b. Do not prune to obtain required sizes.
    - c. Take caliper measurements 6 inches above ground for trees up to 4-inch caliper size and 12 inches above ground for larger sizes.
    - d. Measure main body of tree or shrub for height and spread.
    - e. Do not measure branches or roots tip-to-tip.
  2. Labeling:
    - a. Label each tree and shrub with securely attached waterproof tag bearing legible designation of botanical and common name.
    - b. Where formal arrangements or consecutive order of trees or shrubs are shown, select stock for uniform height and spread, and label with number to assure symmetry in planting.
- C. Observation:
  1. Engineer may observe trees and shrubs either at place of growth or at Site before planting, for compliance with requirements for genus, species, variety, size, and quality.
  2. Engineer retains right to further inspect trees and shrubs for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of Work.
  3. Remove rejected trees or shrubs immediately from Site.
- D. Topsoil Analysis:
  1. Furnish soil analysis by qualified soil-testing laboratory stating percentages of organic matter, gradation of sand, silt and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
  2. Report suitability of topsoil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

- E. Preinstallation Meetings: If requested, installer shall meet with Engineer and landscaping supplier's representative prior to the start of installation.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver trees and shrubs after preparations for planting have been completed and plant immediately.
- B. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer.
- C. Trees and Shrubs:
  - 1. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage.
  - 2. Balled and Burlapped Stock:
    - a. Do not drop during delivery.
    - b. Handle planting stock by root ball.
    - c. Set on ground and cover with soil, peat moss, sawdust, or other acceptable material.
  - 3. Bare Root Stock:
    - a. Immediately after digging up, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.
    - b. Soak roots in water for 2 hours if dried out.
  - 4. Container-grown Stock: Do not remove container-grown stock from containers until planting time.
  - 5. Water root systems of plants stored on-site with a fine-mist spray as often as necessary to maintain in a moist condition.
  - 6. If planting is delayed more than 6 hours after delivery, set trees and plants in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.

### **1.06 PROJECT CONDITIONS**

- A. Existing Conditions:
  - 1. Inspect the Site prior to installation. If conditions do not meet approval, notify Engineer.
  - 2. Proceeding without notification implies acceptance of conditions.
- B. Environmental: Work within seasonal limitations for each kind of landscape work required.
- C. Utilities:
  - 1. Determine location of underground utilities and perform work in a manner which will avoid possible damage.
  - 2. Contact Diggers Hotline (811) at least 48 hours prior to conducting any underground operations.
  - 3. Hand excavate, as required.
  - 4. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

### **1.07 SEQUENCING AND SCHEDULING**

- A. Planting Time: Proceed with, and complete landscape work as rapidly as portions of Site become available, working within seasonal limitations for each kind of landscape work required:
  - 1. Plant or install materials during normal planting seasons for each type of plant material required.
  - 2. Correlate planting with specified maintenance periods to provide maintenance from date of Substantial Completion.
- B. Coordination with Lawns:
  - 1. Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to Engineer.
  - 2. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

## 1.08 WARRANTY

- A. Trees, Shrubs and Perennials: Warranty for a period of 1 year after date of Substantial Completion, against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Installer's control.
- B. Replacement:
  - 1. Remove and replace immediately trees, shrubs, or other plants found to be dead or in unhealthy condition.
  - 2. Replace immediately unless required to plant in succeeding planting season.
  - 3. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
  - 4. A limit of 1 replacement of each exterior plant will be required, except for losses or replacements due to failure to comply with requirements.

## 1.09 MAINTENANCE

- A. Trees and Shrubs:
  - 1. Maintain for 12 months from date of Substantial Completion.
  - 2. Prune, cultivate, water, weed, fertilize, restore planting saucers, tighten and repair stakes and guy supports, and reset to proper grades or vertical position, as required to establish healthy, viable plantings.
  - 3. Spray as required to keep trees and shrubs free of insects and disease.
  - 4. Restore or replace damaged tree wrappings.
- B. Perennials and Bulbs:
  - 1. Maintain for 12 months from date of Substantial Completion.
  - 2. Water, weed, fertilize, and perform other operations as required to establish healthy, viable plantings.

## PART 2 PRODUCTS

### 2.01 SOIL PREPARATION MATERIALS

- A. Topsoil:
  - 1. Fertile, friable natural loam or sandy loam capable of sustaining vigorous plant growth, without admixture of subsoil material, obtained not more than 2 or 3 feet from top of deposit, from well-drained arable site.
  - 2. Free from subsoil, heavy alkaline soil, coarse sand, stones larger than 2 inches in diameter, lumps, clods of hard earth, plant roots, sticks, noxious and invasive weeds, slag, cinders, demolition debris, or other foreign matter.
  - 3. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient.
    - a. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep.
    - b. Do not obtain from agricultural land, bogs, or marshes.
  - 4. ASTM D5268, pH range of 5.5 to 7.
  - 5. Final Topsoil Nutrient Values After Amendment (if required):
    - a. Organic Matter: 4.0 percent minimum, 10.0 percent maximum.
    - b. Extractable Phosphorus: 25 parts per million by weight minimum.
    - c. Exchangeable Potassium: 125 parts per million by weight minimum.
    - d. pH: 5.5 minimum, 7.0 maximum, 6-6.5 preferred.
    - e. Soluble Salts: 3 mmhos/cm maximum.
    - f. Lead Content: Less than 400 parts per million.
- B. On-site Base Mixture: To extent available, and if modified to meet requirements, select on-site material may be used as base mixture for preparation of topsoil.

- C. Import supplemental materials as necessary to satisfy specified topsoil requirements.
- D. Inorganic Soil Amendments:
  - 1. Lime: ASTM C602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
    - a. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.
    - b. Class: Class O, with a minimum 95 percent passing through No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.
    - c. Provide lime in form of dolomitic limestone.
    - d. Untreated finely ground gypsum board scrap, free of contaminants.
  - 2. Sulfur:
    - a. Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.
    - b. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
    - c. Aluminum Sulfate: Commercial grade, unadulterated.
  - 3. Perlite: Horticultural perlite, soil amendment grade.
  - 4. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
  - 5. Sand: Clean, washed, natural or manufactured, free of toxic materials.
  - 6. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
  - 7. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.
- E. Organic Soil Amendments:
  - 1. Compost:
    - a. Well-composted, stable, and weed-free organic matter.
    - b. pH range of 5.5 to 8.
    - c. Moisture content 35 to 55 percent by weight.
    - d. 100 percent passing through 1/2- inch sieve.
    - e. Soluble salt content of 5 to 10 decisiemens/m.
    - f. 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.
      - 3) Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.
  - 2. Wood Derivatives:
    - a. Decomposed, nitrogen-treated sawdust, ground bark, or wood waste.
    - b. Of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
    - c. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with at least 0.15 pound of ammonium nitrate or 0.25 pound of ammonium sulfate per cubic foot of loose sawdust or ground bark.
  - 3. Manure:
    - a. Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials.
    - b. Free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

## 2.02 TREES, SHRUBS AND PLANTS

- A. Provide freshly-dug nursery-grown trees and shrubs complying with ANSI Z60.1.
  - 1. Healthy root systems developed by transplanting or root pruning.
  - 2. Well-shaped, fully branched, healthy, vigorous stock.
  - 3. Free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  - 4. Sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required.

5. Provide trees and shrubs raised in the local region, acclimated to the appropriate climate conditions. Verify source of plant materials and location of nursery where grown.
- B. Deciduous Trees:
1. Provide trees of height and caliper scheduled or shown and with branching configuration recommended by ANSI Z60.1 for type and species required.
  2. Provide single stem trees except where special forms are shown or listed.
  3. Provide balled and burlapped stock.
  4. Container grown deciduous trees will be acceptable in lieu of balled and burlapped deciduous trees subject to specified limitations of ANSI Z60.1 for container stock.
- C. Deciduous Shrubs:
1. Provide shrubs of the height shown or listed and with not less than minimum number of canes required by ANSI Z60.1 for type and height of shrub required.
  2. Provide balled and burlapped (B&B) deciduous shrubs.
  3. Provide bare root deciduous shrubs, except where shown as "B&B", provide balled and burlapped shrubs.
  4. Container grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs subject to specified limitations for container grown stock.
- D. Coniferous and Broad-Leafed Evergreens:
1. Form and Size:
    - a. Normal-quality, well-balanced, of type, height, spread, and shape required.
  2. Complying with ANSI Z60.1.
  3. Dimensions indicate minimum spread for spreading and semi-spreading type evergreens and height for other types, such as globe, dwarf, cone, pyramidal, broad upright, and columnar.
  4. Provide balled and burlapped (B&B) evergreens.
  5. For small evergreens, container grown evergreens will be acceptable, subject to specified limitations for container grown stock.
- E. Perennials:
1. Provide healthy, field-grown plants from a commercial nursery, in removable containers or integral peat pots.
  2. Not less than minimum number and length of runners required by ANSI Z60.1 for the pot size shown or listed.
  3. Vines: Fast growing, complying with ANSI Z60.1.
    - a. 2-year plants with heavy, well-branched tops, with not less than 3 runners 18 inches or more in length.
    - b. Vigorous, well-developed root system.
    - c. Field-grown or grown in pots of other containers of adequate size and acclimated to outside conditions.
- F. Bulbs:
1. Provide healthy bulbs from a commercial nursery.
  2. Dry and dormant.
  3. Disease free.
  4. Well developed bulb and root system.
  5. Complying with ANSI A60.1.
- G. Annuals:
1. Provide healthy plants from a commercial nursery in removable containers or integral peat pots.
  2. Adequate size and acclimated to outside conditions.
  3. Complying with ANSI A60.1.

### 2.03 ACCESSORIES

- A. Fertilizers:
1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10 percent phosphoric acid.

2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
  3. 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:
    - a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
  4. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
    - a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- B. Mulches:
1. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs.
    - a. Shredded hardwood.
    - b. Ground or shredded bark.
    - c. Pine straw.
    - d. Salt hay or threshed straw.
    - e. Wood and bark chips.
    - f. Pine needles.
    - g. Peanut, pecan, and cocoa-bean shells.
  2. Compost Mulch:
    - a. Well-composted, stable, and weed-free organic matter.
    - b. pH range of 5.5 to 8.
    - c. Moisture content 35 to 55 percent by weight.
    - d. 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m.
    - e. 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. Stakes and Guys:
1. Upright and Guy Stakes:
    - a. Wood: Rough-sawn, sound, free of knots, holes, cross grain, and other defects.
    - b. Steel, tapered.
    - c. Aluminum: ASTM B221, alloy 6061-T6.
    - d. 2-inch by 2-inch by length indicated.
    - e. Pointed at one end.
  2. Guy and Tie Wire:
    - a. ASTM A641/A, Class 1.
    - b. Galvanized-steel wire.
    - c. 2-strand, twisted.
    - d. 0.106 inch diameter.
  3. Guy Cable:
    - a. 5-strand, 3/16-inch-diameter.
    - b. Galvanized-steel cable with zinc-coated turnbuckles.
    - c. Minimum of 3 inches long.
    - d. Two 3/8-inch galvanized eyebolts.
  4. Hose Chafing Guard:
    - a. Reinforced rubber or plastic hose at least 1/2 inch in diameter.
    - b. Black.
    - c. Cut to lengths required to protect tree trunks from damage.
  5. Flags:
    - a. Standard surveyor's plastic flagging tape.
    - b. Color: White.
    - c. Size: 6 inches long.



## 2.04 MISCELLANEOUS PRODUCTS

- A. Antidesiccant:
  - 1. Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs.
  - 2. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written directions.
- B. Tree-Wrap Tape:
  - 1. Designed to prevent border damage and winter freezing.
  - 2. 2 layers of crinkled paper cemented together with bituminous material.
  - 3. 4-inch wide minimum.
  - 4. Stretch factor of 33 percent.

## 2.05 SOURCE QUALITY CONTROL

- A. Ship landscape materials with certificates of inspection required by governing authorities.
  - 1. Comply with regulations applicable to landscape materials.
  - 2. Do not prune prior to delivery unless otherwise approved by Engineer.
  - 3. Provide protective covering during delivery.
- B. Substitutions:
  - 1. Do not make substitutions.
  - 2. If specified landscape material is not obtainable, submit proof of non-availability to Engineer, together with proposal for use of equivalent material.
- C. Analysis and Standards:
  - 1. Package standard products with manufacturer's certified analysis.
  - 2. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Lay out individual tree and shrub locations and areas for multiple plantings.
- B. Stake locations and outline areas and secure Architect's acceptance before start of planting work, making minor adjustments as may be required.
- C. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
- D. Provide 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.
- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
- F. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again 2 weeks after planting.
- G. Excavation:
  - 1. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Engineer before planting.
  - 2. Drainage: Notify Engineer if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

- H. Planting Soil:
  - 1. Subsoil:
    - a. After subgrade is established and accepted, loosen to depth of minimum 4 inches.
    - b. Remove sticks, stones, roots and rubbish.
    - c. Smooth over to remove ridges and depressions so surface is parallel to finished grade.
  - 2. Topsoil:
    - a. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
    - b. Do not turn existing vegetation over into soil being prepared for lawns.
  - 3. Soil Amendments:
    - a. Mix Lime with dry soil prior to mixing of fertilizer; prevent lime from contacting roots of acid-loving plants.
    - b. Apply phosphoric acid fertilizer (other than that constituting a portion of complete fertilizers) directly to subgrade before applying planting soil and tilling.
    - c. Mix specified soil amendments and fertilizers with topsoil at rates specified.
    - d. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.
  - 4. Prepare planting soil in the following proportions:
    - a. 1 part existing soil by volume.
    - b. 1 part topsoil by volume.
    - c. 1 part compost by volume.
    - d. 2.9 pounds per cubic yard of 4-4-4 analysis organic slow-release fertilizer.
  
- I. Planting Beds:
  - 1. Loosen subgrade of planting bed areas to a minimum depth of 6 inches using a culti-mulcher or similar equipment.
  - 2. Remove stones measuring over 1-1/2 inches in any dimension, sticks, rubbish and other extraneous matter.
  - 3. Apply fertilizer directly to subgrade before loosening.
  - 4. Thoroughly blend planting soil mix.
  - 5. Mix lime with dry soil before mixing fertilizer.
  - 6. Spread mixture of planting soil and soil amendments to depth shown on Drawings, but not less than required to meet finish grades after natural settlement.
  - 7. Place approximately 1/2 of total amount of planting soil required. Work into top of loosened subgrade to create a transition layer, then place remainder of the planting soil.
  - 8. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
  - 9. Finish grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture.
  - 10. Roll and rake, remove ridges, and fill depressions to meet finish grades.
  - 11. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

### 3.02 PLANTING

- A. Trees and Shrubs to be Transplanted:
  - 1. Excavation of Trees:
    - a. Excavate with hydraulic tree spade.
    - b. Burlap and wire root ball immediately upon excavation.
  - 2. Storage of Trees and Shrubs:
    - a. Stand tree or shrub upright.
    - b. Cover entire root ball with wood chips.
    - c. Entirely soak root ball.
    - d. Keep root ball wet.
  
- B. Excavation:
  - 1. Excavate pits, beds, and trenches with sides sloped inward.
  - 2. Trim base leaving center area raised slightly to support root ball and assist in drainage.
  - 3. Do not further disturb base.
  - 4. Loosen hard subsoil in bottom of excavation.
  - 5. Bare Root: For bare root trees and shrubs, make excavations at least 12 inches wider than root spread and deep enough to allow for setting of roots on a layer of compacted backfill and with

- collar set at same grade level as in nursery, but 1 inch below finished grade at site. Allow for 9 inch setting layer of planting soil mixture.
6. Balled and Burlapped: Make excavations at least half again as wide as the ball diameter and equal to the ball depth, plus 3 inch thick setting layer of planting soil mixture for setting of ball on a layer of compacted backfill.
  7. Container Grown: Excavate as specified for balled and burlapped stock, adjusted to size of container width and depth.
  8. Bulbs: Excavate to a depth 3 times the height of the bulb.
  9. Drain Tile: If required under planted areas, excavate to top of porous backfill over tile.
  10. Subsoil Disposal: Dispose of subsoil removed from planting excavations. Do not mix with planting soil or use as backfill.
  11. Pre-planting Watering: Fill excavations for with water and allow water to percolate away prior to planting.
- C. Planting Trees and Shrubs:
1. Balled and Burlapped:
    - a. Set balled and burlapped (B&B) stock on layer of compacted planting soil mixture, plumb, and in center of pit or trench.
    - b. Place top of ball 1 inch above adjacent finished landscape grades.
    - c. Remove burlap and wire baskets from tops of root balls and partially from sides; retain on bottoms.
    - d. Remove pallets, if any.
    - e. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  2. Bare Root:
    - a. Set bare root stock on cushion of planting soil mixture.
    - b. Spread roots and carefully work backfill around roots by hand.
    - c. Puddle with water until backfill layers are completely saturated.
    - d. Set collar or trunk flare 1 inch below adjacent finish landscape grades.
    - e. Spread out roots without tangling or turning up to surface.
    - f. Cut injured roots clean; do not break.
  3. Container-grown:
    - a. Set container grown stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.
    - b. Cut cans on 2 sides with an approved can cutter and carefully remove after partial backfilling so as not to damage root balls.
  4. Fabric Bag-grown:
    - a. Set container grown stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.
    - b. Carefully remove root ball from fabric bag without damaging root ball or plant.
    - c. Do not use planting stock if root ball is cracked or broken before or during planting operation.
- D. Backfilling:
1. When trees and shrubs are set, place additional backfill around base and sides of ball.
  2. Work each layer to settle backfill and eliminate voids and air pockets.
  3. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill.
  4. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.
- E. Mulching, Pruning, and Protection of Trees and Shrubs:
1. Mulch pits, trenches, and planted areas.
  2. Mulch Placement and Depth: See Drawings.
  3. Work into top of backfill and finish level with adjacent finish grades.
  4. Do not place mulch within 3 inches of trunks or stems.
  5. Prune, thin, and shape trees and shrubs in accordance with standard horticultural practice.
    - a. Prune trees to retain required height and spread.
    - b. Unless otherwise directed by Engineer, do not cut tree leaders.
    - c. Remove only injured or dead branches from flowering trees, if any.
    - d. Prune shrubs to retain natural character.
    - e. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

6. Wrap tree trunks of 2 inches caliper and larger.
    - a. Start at base of trunk and spiral cover trunk to height of first branches.
    - b. Overlap wrap, exposing half the width, and securely attach.
    - c. Inspect tree trunks for injury, improper pruning and insect infestation, and take corrective measures before wrapping.
  7. Guy and Stake Trees:
    - a. Immediately after planting as needed.
    - b. Stake trees of 2- through 5-inch caliper as indicated on Drawings.
      - 1) Stake trees of less than 2-inch caliper only as required to prevent wind tip-out.
      - 2) Set vertical stakes and space to avoid penetrating root balls or root masses.
      - 3) Support trees with 2 strands of tie wire encased in hose sections at contact points with tree trunk.
      - 4) Allow enough slack to avoid rigid restraint of tree.
    - c. Guy and stake trees exceeding 14 feet in height and more than 3 inches in caliper.
      - 1) Anchor guys to pressure-preservative treated deadmen 8 inches in diameter and 48 inches long buried at least 36 inches below grade.
      - 2) Provide turnbuckles for each guy wire and tighten securely.
      - 3) Attach flags to each guy wire, 30 inches above finish grade.
      - 4) Paint turnbuckles with luminescent white paint.
- F. Perennials:
1. Space plants as indicated or scheduled, or if not shown or scheduled, not more than 24 inches on center.
  2. Dig holes large enough to allow for spreading of roots and backfill with planting soil.
  3. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
  4. Water thoroughly after planting, taking care not to cover crowns of plants with wet soils.
  5. Mulch areas between plants; place not less than 2 inches thick.
  6. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.
- G. Planting Bed Mulching:
1. Install weed-control barriers before mulching according to manufacturer's written instructions.
  2. Completely cover area to be mulched, overlapping edges a minimum of 6 inches.
  3. Mulch backfilled surfaces of planting beds and other areas indicated with 3-inch average thickness.
  4. Finish level with adjacent finish grades.
  5. Do not place mulch against plant stems.

### 3.03 CLEANUP AND PROTECTION

- A. During landscape work, keep pavements clean and work area in an orderly condition.
- B. Begin maintenance immediately after planting.
- C. Disposal:
  1. Remove waste and foreign materials, including weeds, stones, soil cores, grass, vegetation, and sod and legally dispose of them off Owner's property.
  2. Divert from landfill disposal whenever possible.
  3. Topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, shall be disposed of legally.
- D. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others.
- E. Maintain protection during installation and maintenance periods.

**END OF SECTION**

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## SECTION 33 01 10

### TRACER WIRE

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide tracer wire (locating wire) and accessories for all non-metallic mains, laterals, and services.
- B. Related Sections:
  - 1. Section 31 23 33 - Trench Excavation and Backfill
  - 2. Section 33 34 00 - Force Mains

##### 1.02 REFERENCES

- A. ASTM D1248 - Polyethylene Plastics Extrusion Materials for Wire and Cable

##### 1.03 QUALITY ASSURANCE

- A. Provide tracer wire designed specifically for the purpose of detecting buried facilities.

#### PART 2 PRODUCTS

##### 2.01 MANUFACTURER

- A. Tracer Wire:
  - 1. Copperhead Industries.
  - 2. Agave Wire.
  - 3. Or equal.
- B. Tracer Wire Access Box:
  - 1. Valvco: Part TWAB.
  - 2. Copperhead: SnakePit Lite Duty.
  - 3. Or Equal.
  - 4. Located at each hydrant and each building entrance location.
- C. Rhino 3-Rail Utility Marker Post:
  - 1. Color:
    - a. Green: Sanitary sewer.
    - b. Blue: Potable and fire water.
    - c. Purple: Cooling water, Recycle/reclaim water.

##### 2.02 MATERIALS

- A. Open Trench Installation:
  - 1. Direct burial 12 AWG solid, 0.0808-inch diameter.
  - 2. Steel core soft drawn, high strength 380-pound average tensile break load.
  - 3. 30 mil high molecular weight, high density polyethylene, complying with ASTM D1248.
  - 4. High flexibility, stretchable to accommodate ground movement.
  - 5. Impact resistant.
  - 6. 30-volt rating.
  - 7. Jacket color: Blue - water, green - sewer, purple - cooling, recycle/reclaim water.
  - 8. Physical, permanent, surface legend on insulating jacket, repeated a minimum of every 2 linear feet.

- B. Pipe Bursting or Horizontal Direction Drilling Installation:
  - 1. Direct burial 12 AWG solid, 0.0808-inch diameter.
  - 2. Steel core hard drawn, extra high strength 1150-pound average tensile break load.
  - 3. 45 mil high molecular weight, high density polyethylene, complying with ASTM D1248.
  - 4. High flexibility, stretchable to accommodate ground movement.
  - 5. Impact resistant.
  - 6. 30-volt rating.
  - 7. Jacket color: Blue - water, green - sewer, purple - recycle/reclaim water.
  - 8. Physical, permanent, surface legend on insulating jacket, repeated a minimum of every 2 linear feet.
  
- C. Connectors:
  - 1. Waterproof and corrosion-proof.
  - 2. Prefilled with non-hardening sealant.
  - 3. Lug: Tin plated high conductivity aluminum with high impact polypropylene housing.
  - 4. CSA certified as both Pressure Type and Direct Bury as well as waterproof and corrosion resistant.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Approved spliced connection locations: Water main tees, crosses, and copper water services.
  
- B. Except for approved splice connections and repairs, install in continuous manner from valve box to valve box, valve box to manhole.
  
- C. Install tracer wire parallel with and above centerline axis of pipe.
  - 1. Do not spiral wrap or tape tracer wire to pipe.
  - 2. Do not install under service saddles.
  
- D. Connections to existing materials:
  - 1. Ductile Iron: Cadweld or equal.
  - 2. Copper: Stainless steel strap to match copper pipe size.
  - 3. Seal with mastic sealer approved for underground use.
  
- E. Terminate tracer wires in accordance with Drawings.
  - 1. Provide 5-pound magnesium anode a maximum of every 1000 feet and at buried pipe ends:
    - a. Attach to the main tracer wire by solder.
    - b. Remove anode protective cover.
    - c. Apply water as directed by manufacturer.
  
- F. Frequency of above ground markers:
  - 1. Place pipe marker outside of roadway:
    - a. Located above pipe in areas where pipe is outside of backslope of road ditch.
    - b. Every 500 to 750 feet.
    - c. At bends or tees.
    - d. Within 10 feet of building entrance location.

### **3.02 FIELD QUALITY CONTROL**

- A. System Testing:
  - 1. Test continuity of conduction in the presence of the Engineer.
  - 2. Connect signal generator at wire termini and trace signal throughout the installation.
  - 3. Locate and repair all breaks in conductivity.

**END OF SECTION**

## SECTION 33 11 00

### WATER DISTRIBUTION SYSTEMS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Water main pipe and fittings.
  - 2. Valves and boxes.
  - 3. Hydrants.
  - 4. Services.
  - 5. Insulation.
  
- B. Related Sections:
  - 1. Section 31 23 33 - Trench Excavation and Backfill
  - 2. Section 33 01 10 - Tracer Wire
  
- C. Method of Measurement:
  - 1. Water Main:
    - a. Measure by distance in linear feet.
    - b. Measure along pipe axis with no deduction for fittings or valves.
    - c. Measure in the horizontal plane unless pipe grade exceeds 15 percent.
    - d. Unit includes tracer wire and thrust restraint.
  - 2. Fittings:
    - a. Measure by weight in pounds.
    - b. Basis of Weight:
      - 1) Meet AWWA C110
      - 2) Exclude weights of glands, gaskets, rods, bolts, and other accessories.
  - 3. Valves and Boxes:
    - a. Measure valve and box of each size and type as a unit.
    - b. Unit includes adjustment to final grade.
  - 4. Hydrants:
    - a. Measure hydrants of each size and type as a unit.
    - b. Unit includes installation of hydrant, base, blocking, hydrant marker flag, and crushed rock.
  - 5. Corporation Stops:
    - a. Measure Corporation Stops of each size and type as a unit.
    - b. Unit includes service saddle.
  - 6. Curb Stops and Boxes:
    - a. Measure curb stops and boxes of each size and type as a unit.
    - b. Unit includes service location marker, box extensions, and 1-foot crimped copper pigtail.
  - 7. Service Pipe:
    - a. Measure by distance in linear feet.
    - b. Measure each size separately.
    - c. Measure from center of water main to center of curb stop plus 1-foot for slack and pigtail.
    - d. Unit includes fittings and tracer wire.
  - 8. Insulation: Measure by volume in board feet.
  - 9. Connection to Existing Water Service or Main
    - a. Measure as a unit for each connection to an existing service or main.
    - b. Unit includes locating, adaptor, and all else necessary to achieve a water-tight connection.
  
- D. Basis of Payment:
  - 1. Payment for acceptable quantities of water main and appurtenances shall be at the Contract Unit Price as listed on the Bid Form. All associated Work items shall be considered incidental.



## 1.02 REFERENCES

### A. ASTM:

1. A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings
2. A307 - Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
3. A536 - Ductile Iron Castings
4. A563 - Carbon and Alloy Steel Nuts
5. B88 - Seamless Copper Water Tube
6. B152 - Copper Sheet, Strip, Plate, Rolled Bar
7. D429 - Tests for Rubber Adhesion to Rigid Surfaces
8. D2842 - Test for Water Absorption of Rigid Cellular Materials
9. D1248 - Polyethylene Plastics Extrusion Materials for Wire and Cable
10. D2737 - Polyethylene (PE) Plastic Tubing
11. D3035 - Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
12. D3350 - Polyethylene Plastics Pipe and Fittings Materials
13. D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
14. F593 - Stainless Steel Bolts, Hex Cap Screws, and Studs
15. F594 - Stainless Steel Nuts
16. F714 - Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter (4 inches and larger)

### B. AWWA:

1. C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
2. C105 - Polyethylene Encasement for Ductile -Iron Pipe Systems
3. C110 - Ductile-Iron and Gray-Iron Fittings
4. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
5. C150 - Thickness Design of Ductile Iron Pipe
6. C151 - Ductile-Iron Pipe, Centrifugally Cast for Water or other Liquids
7. C153 - Ductile-Iron Compact Fittings for Water Service
8. C502 - Dry-Barrel Fire Hydrants
9. C504 - Rubber-Seated Butterfly Valves
10. C509 - Resilient-Seated Gate Valves for Water Supply Service
11. C515 - Reduced-Wall, Resilient-Seated Gate Valves, for Water Supply Service
12. C600 - Installation of Ductile Iron Water Mains and their Appurtenances
13. C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
14. C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch through 12 inch for Water Distribution
15. C901 - Polyethylene (PE) Pressure Pipe and Tubing, 3/4-inch thru 3-inch, for Water Service

### C. NSF/ANSI:

1. 14 - Plastic Piping System Components and Related Materials
2. 61 - Drinking Water System Components - Health Effects
3. 372 - Drinking Water System Components - Lead Content

## 1.03 SUBMITTALS

- A. Submit Certificate of Compliance for products listed under Article 1.04.
- B. Submit proposed method of joint conductivity.

## 1.04 QUALITY ASSURANCE

- A. Provide Certificates of Compliance from the manufacturer certifying that the following products meet the respective requirements listed in Article 1.02:
  1. Pipes
  2. Hydrant
  3. Valves and Boxes

## 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inspection:

1. Inspect all pipe and products during the unloading process.
  2. Notify ENGINEER of any cracked, flawed or otherwise defective products.
  3. Remove all products found to be defective by the ENGINEER from the Site.
- B. Handling and Storage: Handling and storage of products shall be in accordance with AWWA C600 or C605.

## **PART 2 PRODUCTS**

### **2.01 WATER MAIN PIPE**

- A. Ductile Iron: AWWA C151.
1. Cement-Mortar Lining: AWWA C104.
  2. Thickness Class:
    - a. 8-inch and smaller: 52.
    - b. 10-inch and larger: 50.

### **2.02 FITTINGS**

- A. Ductile Iron: AWWA C153.
- B. Cement-Mortar Lining: AWWA C104.
- C. Finish:
1. Protective coatings:
    - a. Fusion-bonded epoxy coating:
      - 1) AWWA C116.
      - 2) Exterior and interior surfaces.
      - 3) Thickness: 6-8 mils.
- D. Joints: Mechanical with ASTM F593 and F594 type 304 Stainless Steel bolts and nuts.

### **2.03 VALVES AND BOXES**

- A. Gate Valves:
1. Resilient Seated: AWWA C515.
  2. Working Pressure: 200 psi.
  3. Ends: Mechanical Joint with ASTM F593 and F594 type 304 Stainless Steel bolts and nuts.
  4. Wedge: Ductile Iron, complete rubber encapsulated.
  5. Operating Stem: Non-Rising with O-ring Seals.
  6. Operating Nut: 2-inch Square, Open Left.
  7. Markings to be cast on the bonnet or body:
    - a. Open indicating arrow.
    - b. Manufacturer's name.
    - c. Pressure rating.
    - d. Year of manufacture.
    - e. Size.
  8. Finish:
    - a. Fusion-bonded epoxy coating complying with AWWA C550.
    - b. Interior and exterior surfaces.
- B. Boxes:
1. Cast Iron, 5-1/4-inch shaft.
  2. Vertical, 3-piece, Buffalo type.
  3. Box length to provide for 6 feet of pipe cover.
  4. Adjustable to 6 inches up or down from standard box length.
  5. Tyler/Union 6860 series with Number 6 base, or equal.

6. Drop lids:
  - a. 5-1/4 inch.
  - b. Marked "Water".
7. Adapter: Adaptor Inc. Valve Box Adaptor II, or equal.

## 2.04 HYDRANTS

- A. Dry Barrel: AWWA C502.
- B. Waterous Pacer WB67 or equal.
- C. Hose Connections: 2 each at 2-1/2-inch diameter.
- D. Steamer Connection: 1 each at 4-1/2-inch diameter.
- E. Threads: National Standard. **NOTE:** Verify with Owner
- F. Operating Stem: Open Left with O-ring Seals.
- G. Traffic flange.
- H. Hub: 6-inch Mechanical Joint with ASTM F593 and F594 type 304 Stainless Steel bolts and nuts.
- I. Main Valve Opening: 5-inch diameter.
- J. Barrel Diameter: 5 inches.
- K. Drain to operate only when hydrant is closed.
- L. Provide "No-Drain Pump After Use" aluminum tag for no-drain applications.
- M. Bury Depth: 6 feet (ground to bottom of hub).
- N. Minimum Nozzle Height (from flange): 30 inches.
- O. Cap Nuts: Pentagon.
- P. Color: Red.
- Q. Provide permanent markings which indicate:
  1. Manufacturer's name.
  2. Year of manufacture.
  3. Bury depth.
- R. Accessories:
  1. Hydrant flags:
    - a. FlexStake, RoDon Hydra-Finder, Nordic Flexi-Flag, or equal.
    - b. Color: Red.
    - c. Polyurethane hinge.
    - d. Length: 5 feet.

## 2.05 INSULATION

- A. Rigid, extruded polystyrene board insulation.
- B. Thermal Resistance (R): 5.0.
- C. Thickness: 2 inches.

- D. Board Size: 48 inch by 96 inch.
- E. Compressive Strength: Minimum 25 psi.
- F. Water Absorption in accordance with ASTM D2842: 0.1 percent by volume, maximum.
- G. Edges: Square.

## **2.06 ENCASEMENT**

- A. Polyethylene Sheet: AWWA C105 Low Density
- B. Thickness: 8 mil

## **PART 3 EXECUTION**

### **3.01 CONSTRUCTION REQUIREMENTS**

- A. Connection to Existing System:
  - 1. Pressure Tap:
    - a. Install tap in location shown on the Drawings.
    - b. Use approved tapping machine designed specifically for tapping under pressure.
    - c. Install tapping sleeve and gate valve as part of assembly.
    - d. Install blocking as required.
- B. Pipe Installation:
  - 1. Install pipe at the alignment and grade shown on the Drawings.
  - 2. Provide a minimum of 6 feet of cover over the pipe.
  - 3. Install appurtenances in the locations shown on the Drawings.
  - 4. Remove all dirt and foreign material from the pipe interior prior to installation.
  - 5. See Section 31 23 33 for pipe foundation and backfill procedures.
  - 6. See Section 31 23 33 in case of conflicts with existing pipes.
- C. Valve and Box Installation:
  - 1. Verify that subgrade material is adequate to support valve assembly.
  - 2. Install valves with stems vertical and plumb.
  - 3. Install boxes plumb and centered over the valve nut.
  - 4. Verify that box remains plumb and centered during backfill.
  - 5. Adjust box cover to required grade.
- D. Hydrant Installation:
  - 1. Verify that subgrade material is adequate to support hydrant.
  - 2. Place thrust block, crushed rock and tar paper in accordance with Drawing details.
  - 3. Install and maintain hydrant in a plumb position.
  - 4. Where groundwater is present, plug drain hole and affix "Pump After Use" tag to the hydrant.
- E. Joint Conductivity:
  - 1. Provide electrical bond across all joints between pipes and appurtenances.
  - 2. Install copper jumpers by either shop or field applications.
  - 3. Fasten multiple jumper strips with silicon bronze bolts and nuts.
  - 4. Welding:
    - a. Grind surfaces to be welded to remove coating and oxide and to provide clean metal surface.
    - b. Use metallic-arc process for shop applications.
    - c. Use exothermic process for field applications.
    - d. Refinish welded area with protective coating after connection is made.

F. Thrust Restraint:

1. Install thrust restraints at all bends, tees and plugs.
2. Concrete Blocking:
  - a. Place between the fitting and undisturbed trench wall.
  - b. Minimum thickness: 12 inches.
  - c. Minimum area in square feet shall be in accordance with the following:

Pipe	Tee or Plug	1/4 Bend	1/32 and 1/8 Bend	1/16 Bend
6 inch	2.9	3.1	1.6	0.8
8 inch	3.7	5.3	2.9	1.4
10 inch	5.7	8.1	4.4	2.2
12 inch	8.1	13.4	6.6	3.2
16 inch	15.1	21.4	11.6	5.9
20 inch	23.2	30.2	18.1	9.3
24 inch	33.6	48.5	26.1	13.3

- d. Size blocking based on the larger main.
- e. Verify that bolts are accessible after concrete is poured.
3. Timber Blocking:
  - a. Use for temporary blocking only for maximum 8-inch mains.
  - b. Minimum timber size: 4 inch by 4 inch.
4. Restrained Joints:
  - a. Submit method and type to ENGINEER for approval.
  - b. Install in accordance with manufacturer's recommendations.

G. Encasement:

1. Comply with AWWA C105.
2. Wrap all pipe and fittings in the location shown on the Drawings.
3. Clean all surfaces of pipe and appurtenances prior to wrapping.
4. Provide sufficient slack to prevent damage during backfill.
5. Provide minimum 6-inch overlap at joints.
6. Secure overlap and joints with compatible adhesive tape.
7. Repair damaged wrap with tape or polyethylene patch.

**3.02 FIELD QUALITY CONTROL**

A. Perform the following tests upon completion of the system and prior to being placed into service:

1. Pressure and Leakage Test:
  - a. Perform pressure and leakage test in accordance with AWWA C600.
  - b. Test Pressure: 150 psi.
  - c. Test Duration: 2 hours.
  - d. Gage Requirements:
    - 1) Size: 4-1/2-inch dial.
    - 2) Range: 0 to 200 psi.
    - 3) Gradation: 2 psi.
    - 4) Accuracy: 1/2 percent.
  - e. Do not allow pressure to vary more than 5 psi during the test.
  - f. Do not allow pressure to vary more than 2 psi during the last hour of the test.
  - g. Allowable Leakage: One-half of the volume allowed by AWWA C600 in accordance with the following:

$$L = \frac{SD\sqrt{P}}{296,000}$$

- L = Allowable Leakage in Gallons Per Hour  
 S = Length of Pipe Tested in Feet  
 D = Nominal Diameter of Pipe in Inches  
 P = Average Test Pressure During Test in Pounds/Square Inch (Gage)

2. Electrical Conductivity Test:
  - a. Perform electrical conductivity test to verify that electrical thawing of the system may be accomplished by Owner.
  - b. Test Parameters:
    - 1) Perform test within 1 week after pressure testing.
    - 2) Perform test after back-filling is completed and while line is at normal operating pressure.
    - 3) Test Current: 350 amperes DC plus or minus 10 percent.
    - 4) Test Duration: 5 minutes.
    - 5) Test between hydrants in segments of convenient length.
  - c. Procedures:
    - 1) Furnish DC current source, cable and all required equipment of adequate capacity to accomplish the test.
    - 2) Clamp cables to hydrant flange bolts.
    - 3) Conduct test with hydrant in the open position and caps on.
    - 4) Measure current continuously throughout the test with a DC ammeter hooked on a cable lead.
    - 5) Start test at minimum current level and increase to test level.
    - 6) Drain hydrant and tighten caps after test.
  - d. Failure and Correction:
    - 1) Failure of a segment shall be determined by current measurements that are insufficient, intermittent or unsteady.
    - 2) Isolate and correct defective contact points as indicated by failed tests.
    - 3) Retest failed segments after correction.

### 3.03 DISINFECTION

- A. Disinfect, flush, and test all temporary water piping prior to use.
- B. Disinfect all newly installed water mains, appurtenances and services in accordance with AWWA C651.
  1. Tablet or Continuous Feed Method:
    - a. Hold chlorine solution in pipe for a minimum period of 24 hours.
      - 1) Initial dosage: 50 ppm minimum.
      - 2) Residual dosage after hold period: 10 ppm minimum.
- C. Flush system within 24 hours after disinfection is completed.
- D. Sampling and Testing:
  1. After final flushing, obtain 2 sets of samples taken a minimum of 24 hours apart.
  2. Each sample set shall include:
    - a. One sample for every 1,200 feet of main.
    - b. One sample at each dead-end.
    - c. Ensure that 1 sample is obtained from each branch of main.
    - d. Minimum sample required: 2.
  3. Perform coliform tests on each sample.
  4. Rechlorinate if any sample tests positive for coliform.

### 3.04 AS-BUILT RECORDS

- A. Record accurate locations of sewer and water services installed as part of this Project, in accordance with the following:
  1. Measure and record all locations and elevations of all appurtenances.

**END OF SECTION**

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## SECTION 33 16 50

### SUBMERSIBLE TANK MIXING SYSTEM

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Submersible mixing system.
  - 2. Accessories.
  - 3. Electrical Power Connection.

##### 1.02 PERFORMANCE REQUIREMENTS

- A. Sized to completely mix a minimum 3,060,037-million-gallon water storage tank with a tank height of 20.35 feet, tank diameter of 160 feet, and hatch size of 12 inches, pulling water from the lower level of the tank and pushing it upward, high flow.

##### 1.03 SUBMITTALS

- A. Mixing System:
  - 1. Mixing unit Size and Model Number.
  - 2. Mixing system Specifications & Dimensions.
  - 3. Head Capacity & Horsepower Curves.
  - 4. Motor Specifications.
  - 5. Interior Water Wiring Plan
  - 6. Installation diagram and instructions showing wiring and mounting assembly.
  - 7. Operations and Maintenance Manual.

#### PART 2 PRODUCTS

##### 2.01 ELECTRIC SUBMERSIBLE MIXER

- A. GridBee GS-12 or approved equal.
- B. Nominal Dimensions:
  - 1. Length: 36 inches.
  - 2. Height: 10 inches.
  - 3. Width: 10 inches.
- C. Weight - 80 pounds maximum.
- D. 120 Volt AC.
- E. NSF/ANSI Standard 61 and NSF/ANSI 372 approved components.

##### 2.02 ACCESSORIES

- A. Include items for a complete system including, but not limited to, the following.
  - 1. Control Box:
    - a. UL listed, NEMA 4X.
    - b. 120VAC, 1 Ph, 60 Hz.
    - c. SCADA Monitoring Capability.
    - d. HAND-OFF-AUTO switch.
    - e. Indicator light.



- f. Locking hatch.
  - g. Control Box shall include a 4-20 mA current transducer providing analog output for motor current allowing for monitoring proper operation.
  - h. Control Box shall include a 24 VDC relay to allow for remote on and off control of the mixer.
  - i. Integration of 4-20 mA output and remote on/off relay into existing PLC/RTU shall be provided by an approved controls system integrator.
2. Power Cord.
  3. Retrieval Chain.
  4. Cord penetrator bolt.
  5. Power cable penetration thru-tank fitting.
  6. Chemical Injection hose penetration thru-tank fitting. Allow for conversion from 2" electrical conduit to tank fitting. Fitting design shall be such that the chemical injection hose is not damaged during operation.
  7. Suspension kit.
  8. Grip cord.
  9. Mounting accessories.
  10. Junction Box.
  11. NEMA 4x Control Box with SCADA Monitoring.
  12. Chain grab tools.
  13. O&M Manual.
  14. Installation Sealant.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify location of other riser amenities to avoid conflicts with system installation.

### **3.02 INSTALLATION**

- A. Install mixer in accordance with manufacturer recommendations through existing vent opening at top of tank.
- B. Install within reach of the tank access manway.
- C. Contractor shall take care as to not allow debris to enter the tank. If debris enters the tank, Contractor shall disinfect the tank according to AWWA C652, Method 3.
- D. Install mixer control panel with Hand-Off-Auto switch and on/off indicating light in Chemical Feed Station.
- E. Demonstrate proper operation.
- F. Install standard 75-foot cable and chain, top of tank roof junction box, through-tank fitting, chain grab tools, 1 5/16-inch hole saw, Lexel sealant, kellem grip and cord seal.

### **3.03 ELECTRICAL**

- A. Secure and pay for the services of a licensed electrician.
- B. Furnish and install all necessary electrical components to provide power to mixer.
- C. Route power inside appropriate rigid PVC conduit.
- D. Maintain electrical devices and equipment including SCADA features.
- E. Complete all work in a workmanlike manner.

### **3.04 FIELD QUALITY CONTROL**

- A. Manufacturer Field Services:
  - 1. Representative to supervise and inspect mixer installation.

### **3.05 DISINFECTION**

- A. Disinfect mixing system prior to placing unit into tank.
- B. If the Contractor causes debris to enter the tank, disinfection of the entire tank will be required according to AWWA C652, Method 3.

### **3.06 WARRANTY**

- A. 5-year extended warranty.

**END OF SECTION**

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## SECTION 33 31 00

### SANITARY SEWER SYSTEMS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Gravity sanitary sewer pipe.
  - 2. Sanitary manholes and appurtenances.
  - 3. Service connections.
  - 4. Service pipe.
  - 5. Riser pipe.
  
- B. Related Sections:
  - 1. Section 31 23 34 - Trenching, Backfilling and Compaction
  - 2. Section 33 01 10 - Tracer Wire
  
- C. Method of Measurement:
  - 1. Sewer Pipe:
    - a. Measure by distance in linear feet.
    - b. Measure along longitudinal axis from manhole centers with no deduction for fittings.
    - c. Measure each pipe size, class, and depth zone separately.
  - 2. Manholes:
    - a. Measure each size and type individually as a unit.
    - b. Unit includes granular foundation, base, precast barrel and cone sections, steps, rings, frame, and cover to a depth of 10 feet.
    - c. Measure depth from lowest invert to top of frame.
  - 3. Excess Manhole Depth:
    - a. Measure by distance in linear feet.
    - b. Measure total distance from lowest invert to top of frame less 10 feet.
  - 4. Manhole Drop Section:
    - a. Measure by distance in linear.
    - b. Measure from upper to lower pipe invert.
    - c. Unit includes base extension, fittings, drop pipe, collar, and differential cost of special lateral pipe material.
  - 5. Manhole Connections:
    - a. Measure connections to an existing manhole as a unit.
    - b. Unit includes cutting and patching of manhole wall and base, and construction of a new invert.
  - 6. Service Connections: Measure fittings of each size and type as a unit.
  - 7. Service Pipe:
    - a. Measure by distance in linear feet of each size.
    - b. Measure horizontally from end of riser fitting to end of pipe.
  - 8. Riser Pipe:
    - a. Measure by distance in linear feet for each size.
    - b. Measure vertically from end of service wye connection fitting to end of riser fitting.
  
- D. Basis of Payment:
  - 1. Payment for acceptable quantities of sanitary sewer items shall be at the Contract Unit Price as listed on the Bid Form.
  - 2. All associated Work items shall be considered incidental.
  - 3. Maintaining sanitary sewer service during construction shall be considered incidental.

## **1.02 REFERENCES**

### **A. ANSI:**

1. A21.4 - Standard for Cement - Mortar Lining for Ductile Iron Pipe and Fittings
2. A21.11 - Standard for Rubber - Gasket Joints for Ductile Iron Pressure Pipe and Fittings
3. A21.51 - Standard for Ductile Iron Pipe Centrifugally Cast
4. A21.53 - Standard for Ductile Iron Compact Fittings, 3-inch through 16-inch

### **B. ASTM:**

1. A48 - Specification for Gray Iron Castings
2. A74 - Specification for Cast Iron Soil Pipe and Fittings
3. C76 - Specification for Reinforced Concrete Pipe
4. C361 - Specification for Reinforced Concrete Low Head Pressure Pipe
5. C425 - Specification for Compression Joints for VCP and Fittings
6. C478 - Specification for Precast Reinforced Concrete Manhole
7. C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
8. D2321 - Recommended Practice for Installation of Flexible Thermo-plastic Sewer Pipe
9. D3034 - Specification for PVC Sewer Pipe and Fittings
10. F477 - Elastomeric Seals for Joining Plastic Pipe
11. F714 - Specification for PE Sewer Pipe and Fittings

## **1.03 SUBMITTALS**

A. Submit Shop Drawings for each manhole.

B. Quality Assurance/Control Submittals:

1. Submit Certificates of Compliance from manufacturers certifying that materials meet reference specifications listed in Article 1.02.
2. Submit record of service connections weekly to Engineer.

## **1.04 HANDLING AND DELIVERY OF MATERIALS**

A. Inspect pipe and materials during unloading process and notify Engineer of cracked, flawed or otherwise defective material.

## **1.05 STAKING**

A. Engineer shall provide necessary staking for all Work under this Section.

## **1.06 MAINTAINING SEWER SYSTEM**

A. Maintain flow in sanitary sewers on continuous basis while construction is underway.

B. Plug sewers with inflatable plug. Provide pumps, portable generators, hoses, and related items appurtenant to the Work.

## PART 2 PRODUCTS

### 2.01 PIPE AND FITTINGS

A. Provide the following:

Material	Class	Joint
PVC	SDR 35 ASTM D3034 ASTM F477	Elastomeric Gasket Water Stop Gasket
Cement Lined Ductile Iron	Class 52 ANSI A21.4 ANSI A21.11 ANSI A21.51 ANSI A21.53	Push-On (Pipe) Mechanical (Fittings)
HDPE	SDR 17	Butt-Fusion

B. Provide pipe and fittings of each material type from same manufacturer.

### 2.02 MANHOLES

A. Precast Sections:

1. ASTM C478.
2. Cone: Eccentric.
3. Pipe Joints: Gasketed, watertight.

B. Covers and Frames:

1. ASTM A48:
  - a. Type A: Neenah R1661, self-sealing lid with solid gasket, concealed pick-hole, not non-rocking.
  - b. Adjustment Rings: Concrete, polypropylene, or approved equal, meeting AASHTO M-306, H-25, and HS-25 support requirements

C. Steps:

1. ASTM C497
2. Steel, plastic coated
3. 16inch center on center

D. Manhole Boots:

1. ASTM C923

E. Chimney Seals: Internal/External Seals - Adaptor Inc. or approved equal.

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Line and Grade: Provide means for accurately transferring line and grade from ground surface stakes to working point in trench.

B. Water Stops: Provide in manholes as required to prevent infiltration into system.

### 3.02 CONSTRUCTION REQUIREMENTS

A. Pipe Installation:

1. Comply with ASTM D2321 for PVC installation.
2. Inspect pipe for defects and cracks while suspended before lowering into trench.

3. Place pipe bell at upstream end of pipe length.
  4. Install pipe from lower to higher invert elevation at a uniform slope between manholes.
  5. Place plug in end of incomplete piping at end of day and when Work stops.
  6. Provide watertight plugs at future connection plugs.
  7. When water is present in trench, seals are to remain in-place while trench is pumped completely dry.
  8. See Section 31 23 33 for pipe foundation and backfill.
  9. Maximum Allowable Deviation From Staked Grade:
    - a. Alignment: 0.30 feet.
    - b. Elevation: 0.02 percent.
- B. Manhole Installation:
1. Place precast manhole base on compacted granular subgrade.
  2. Locate steps within 1 inch of vertical alignment and within 1 inch of required vertical spacing.
  3. Provide monolithic base for drop manholes.
  4. Maximum Allowable Deviation From Staked Grade:
    - a. Alignment: 0.30 feet.
    - b. Elevation: 0.03 feet.

### 3.03 FIELD QUALITY CONTROL

- A. Remove all dirt and foreign material from pipe interior prior to testing.
- B. Gravity Sewer Pipe:
1. Pipe Diameter 27 Inches and Smaller: Air test.
  2. Pipe Diameter Larger Than 27 Inches: Infiltration test.
- C. Perform the following tests upon completion of sewer construction and prior to any external plumbing connections:
1. Infiltration Test:
    - a. Manholes shall be watertight, with no leakage permitted.
    - b. Place 90-degree V-notch weirs in locations directed by Engineer to measure leakage in sewer lines.
    - c. Allowable leakage rate shall be 100 gallons/day/inch diameter/mile of sewer between any adjacent manholes.
    - d. Provide corrective measures for lines exceeding the allowable leakage rate.
  2. Air Test:
    - a. Place inflatable sewer stoppers in manhole at each end of reach to be tested.
    - b. Connect 1 end of an air hose to plug used for air inlet.
    - c. Connect other end of hose to portable air control equipment.
    - d. This equipment consists of valves and pressure gages used to control the rate air flows to the test section and to monitor air pressure inside the pipe.
    - e. Connect an air hose between compressor (or other source of compressed air) and control equipment.
    - f. Add air to pipe section. Monitor air pressure so pressure inside pipe does not exceed 5.0 psig.
    - g. When pressure reaches 4.0 psig, stop air supply so internal pressure is maintained for 2 minutes.
    - h. These 2 minutes allow time for air temperature to come to equilibrium with the pipe walls.
    - i. During this time check plugs with soap solution to detect any plug leakage. If plugs are found to leak, bleed off air, tighten plugs, and begin again by supplying air.
    - j. After temperature has been allowed to stabilize for 2 minutes, disconnect air supply and allow pressure to decrease to 3.5 psig.
    - k. At 3.5 psig, start stopwatch to determine time required for pressure to drop to 2.5 psig.
    - l. Provide corrective measures for any line not meeting requirements.
    - m. Test results are usually better if sewer pipe walls are damp at time of testing.
    - n. Time shall be equal to or greater than the allowable time shown in table at end of this Section.

3. Deflection Test:

- a. Perform on PVC pipe at least 30 days after trench backfill has been placed.
- b. Perform test by pulling a mandrel through each line between manholes without aid of mechanical pulling devices.
- c. Mandrel diameter: Minimum 95 percent of the base inside diameter of the pipe as follows:

<b>Nominal Size (in.)</b>	<b>Base I.D.</b>	<b>5% Deflection Mandrel</b>
4	3.874	3.68
6	5.742	5.46
8	7.665	7.28
10	9.563	9.08
12	11.360	10.79
15	13.897	13.20
18	16.975	16.13
21	20.004	19.01
24	22.481	21.36
27	25.326	24.06
30	28.639	27.21
33	32.224	30.61
36	35.808	34.02
42	40.401	38.38
48	46.094	43.79

- d. The line will be considered acceptable if mandrel can progress through line without binding.
- e. Provide corrective measures for lines not meeting these requirements.



**Time Required for a 0.5 PSIG Pressure Drop for Size and Length of Pipe Indicated**

1 Pipe Diameter (inches)	2 Minimum Time (minutes:seconds)	3 Length for Minimum Time (feet)	4 Time for Longer Length (seconds)	Specified Minimum for Length (L) Shown (minutes:seconds)								
				100 feet	150 feet	200 feet	250 feet	300 feet	350 feet	400 feet	450 feet	
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23	115:23
42	19:74	57	20.942 L	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04	157:04
48	22:67	50	27.352 L	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09	205:09

**END OF SECTION**

## SECTION 40 23 00

### PROCESS PIPING GENERAL PROVISIONS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. General provisions relating to process piping, valves, and related accessories.
- B. Related Sections:
  - 1. Section 09 97 20 - Coating Systems for Industrial Facilities
  - 2. Section 40 23 10 - Process Water and Waste Piping
  - 3. Section 40 23 30 - Process Piping Specialties
  - 4. Section 40 23 40 - Process Piping Hangers and Supports
  - 5. Section 40 23 50 - Process Piping Testing, Adjusting, and Disinfection
  - 6. Section 40 92 13 - Process Regulating Valves
  - 7. Section 40 92 40 - Process Valve Actuators

##### 1.02 REFERENCES

- A. ASTM:
  - 1. A53 - Specification for Pipe, Steel, Black and Hot Dipped Zinc Coated Welded and Seamless
  - 2. A126 - Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
  - 3. A774 - Specification for As-welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
  - 4. A778 - Specification for Welded, Unannealed Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
  - 5. B62 - Specification for Composition Bronze or Ounce Metal Castings
  - 6. F439 - Specification for Socket Type Chlorinated Polyvinyl Plastic (CPVC) Pipe Fittings
  - 7. F441 - Specification for Chlorinated Polyvinyl Chloride (CPVC) Schedule 40/80 Piping
  - 8. D1785 - Specification for Polyvinyl Chloride (PVC) Schedule 04/80/120 (for Pressure Piping Applications)
  - 9. D2310 - Classification for Machine -Made Fiberglass Reinforced Thermosetting Resin Pipe
  - 10. D2464 - Specification for Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
  - 11. D2467 - Specification for Socket Type Polyvinyl Chloride (PVC) Plastic Pipe Fittings
  - 12. D2997 - Specification for Centrifugally Cast Fiberglass Reinforced Thermosetting Resin Pipe
  - 13. D3034 - Specification for type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
  - 14. D3350 - Specification for Polyethylene Plastic Pipe and Fittings Material
- B. AWWA:
  - 1. C104 - American National Standard for Cement - Mortar Lining for Ductile Iron Pipe and Fittings for Water
  - 2. C110 - American National Standard for Ductile Iron and Gray Iron Fittings, 3-Inches Through 48-Inches for Water and Other Liquids
  - 3. C111 - American National Standard for Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
  - 4. C115 - American National Standard for Flanged Ductile Iron Pipe with Threaded Flanges
  - 5. C150 - American National Standard for Flanged Ductile Iron Pipe with Threaded Flanges
  - 6. C151 - American National Standard for Ductile Iron Pipe, Centrifugally Cast-In-Metal Molds or Sand Line Molds, for Water and Other Liquids
  - 7. C153 - American National Standard for Ductile Iron Compact Fittings for Water Service
  - 8. C200 - Standard for Steel Water Pipe 6-Inches or Larger
  - 9. C203 - Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
  - 10. C206 - Field Welding of Steel Water Pipe

11. C207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4-Inches Through 144-Inches
12. C500 - Standard for Gate Valves, for Water and Sewerage Systems
13. C504 - Standard for Rubber Seated Butterfly Valves
14. C508 - Standard for Swing Check Valves for Waterworks Service, 2-Inches Through 24-Inches NPS
15. C509 - Standard for Resilient-Seated Gate Valves for Water Supply Service
16. C510 - Standard for Double Check Valve Backflow Prevention Assembly
17. C512 - Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
18. C540 - Power Actuating Devices for Valves and Sluice Gates
19. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances
20. C606 - Standard for Grooved and Shouldered Joints
21. C651 - Standard for Disinfecting Water Mains

### 1.03 SYSTEM DESCRIPTION

- A. Piping System:
  1. Provide a complete and fully operational process piping system inclusive of all appurtenances not specifically shown or covered by the Contract Documents but required for complete operation of the process system.
  2. Assume full responsibility for any additional costs that may result from unauthorized deviations from the Contract Documents.

### 1.04 SUBMITTALS

- A. Shop Drawings:
  1. Exterior yard piping drawings (minimum scale 1-inch equals 10-feet) with information including:
    - a. Dimensions of piping lengths.
    - b. Centerline elevations of piping crossings.
    - c. Acknowledgement of bury depth requirements.
    - d. Details of fittings, tapping locations, thrust blocks, restrained joint segments, harnessed joint segments, hydrants, and related appurtenances.
    - e. Acknowledge designated valve or gate tag numbers, manhole numbers, instrument tag numbers, pipe and line numbers.
    - f. Line slopes and vents.
  2. Interior piping drawings (minimum scale 1/8-inch equals 1-foot) with information including:
    - a. Dimensions of piping from column lines or wall surfaces.
    - b. Centerline dimensions of piping.
    - c. Centerline elevation and size of intersecting ductwork, conduit/conduit racks, or other potential interferences requiring coordination.
    - d. Location and type of pipe supports and anchors.
    - e. Locations of valves and valve actuator type.
    - f. Details of fittings, tapping locations, equipment connections, flexible expansion joints, connections to equipment, and related appurtenances.
    - g. Acknowledgement of valve, equipment and instrument tag numbers.
    - h. Provisions for expansion and contraction.
    - i. Line slopes and air release vents.
  3. Schedule of interconnections to existing piping and method of connection.
- B. Test Reports:
  1. Copies of pressure test results on all piping systems.
  2. Reports defining results of dielectric testing and corrective action taken.
  3. Disinfection test report.
  4. Notification of time and date of piping pressure tests.
- C. Operation and Maintenance Manuals: See Section 01 78 23.

## 1.05 QUALITY ASSURANCE

- A. The physical and chemical properties of all materials, design, performance characteristics and methods of construction and installation of all process items shall be in accordance with applicable current editions of the following standards, references, and guidelines.
  - 1. American Water Works Association (AWWA)
  - 2. American Society for Testing and Materials (ASTM)
  - 3. American Society of Mechanical Engineers (ASME)
  - 4. American National Standards Institute (ANSI)
  - 5. Occupational Safety and Health Act (OSHA)
  - 6. National Electrical Manufacturers Association (NEMA)
  - 7. Institute of Electrical and Electronic Engineers (IEEE)
  - 8. Underwriters Laboratories, Inc. (UL)
  - 9. The Chlorine Institute
  - 10. Pipe Fabrication Institute
- B. All materials, equipment and their installation shall comply with the applicable sections of the following current codes:
  - 1. Wisconsin Chapter NR 811.
  - 2. Recommended Standards for Water Works ("10 State Standards"), Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.
- C. Provide Certificates of Compliance from the manufacturer certifying that the particular product meets the respective requirements for that item.
- D. All welding shall be performed by ASME certified welders. Submit copies of the welder's certification to the Engineer prior to any welds made.

## 1.06 DELIVERY, STORAGE AND HANDLING:

- A. Inspection:
  - 1. Inspect all pipe and products as it is received to determine damage and/or missing parts.
  - 2. Notify Engineer of any missing, damaged, or defective products.
  - 3. Remove all products found to be defective by the Engineer from the site.
  - 4. Repair or replace damaged items in accordance with the manufacturer's instructions.
- B. Handling and Storage: Handling and storage of products shall be in accordance with Section 22 of AWWA C600.

## 1.07 SCHEDULING

- A. Schedule all process work in phases to accommodate the Owner's occupancy and treatment requirements.
- B. Inform the Owner and Engineer at least 48 hours in advance of any service interruption, disruption to construction activities, or to the existing process system operation. Do not proceed until the Owner has granted approval.

## PART 2 PRODUCTS

### 2.01 PROCESS PIPING MATERIALS

- A. Materials used shall be in accordance to the requirements for class and size as specified or shown on the Drawings.
- B. All portions of the process piping system shall be capable of handling stresses that may occur during fabrication, installation, pressure testing and intermittent or continuous operation.

## **2.02 FINISHES**

- A. All piping, fittings, valves and related products and equipment shall be finished, color coded, and labeled in accordance with Section 09 97 20.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Determine locations and dimensions of existing structures, piping, and equipment associated with or potentially interfering with the proper fabrication and installation of proposed work.
- B. Coordinate final length and location of required pipe connections to all process equipment to meet the recommendations and requirements of the equipment manufacturer subject to approval of the Engineer.
- C. No work shall be installed that directly connects to equipment until such time as complete Shop Drawings of said equipment have been reviewed by the Engineer.
- D. Determine and be responsible for the proper locations and character of all hangers, chases, sleeves and other openings in the construction required for all process piping work.
- E. Refer to other drawings for exact locations of partitions, walls, doors, equipment, etc.

### **3.02 INSTALLATION**

- A. Exposed Process Piping, Valves, Supports, and Accessories
  1. Provide piping systems in accordance with the manufacturer's instructions and recommendations.
  2. Provide ductwork, piping, electrical connections, valves, and appurtenances recommended by the manufacturer for proper operation to complete the operation.
  3. Install all process piping systems to facilitate accessibility for maintenance and/or replacement.
  4. Protect all work from subsequent construction activity.
  5. Inplace components will be salvaged at the discretion of the Owner.
    - a. Remove and deliver salvaged items as directed by Owner.
    - b. Non-salvaged items will become property of the Contractor and promptly removed from the Site.

### **3.03 CONNECTIONS WITH EXISTING PIPING**

- A. Where connection between new and existing work is made, use suitable and proper fittings to suit conditions encountered.
- B. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.
- C. Where connection involves potable water systems, provide disinfection methods as prescribed in these Specifications.

### **3.04 PROTECTION**

- A. When pipe installation is not in progress, keep pipe and fitting openings, including manholes, tightly closed.
- B. Closures shall be suitable to prevent entrance of animals, foreign materials, and extraneous water into the process system.

**END OF SECTION**

## SECTION 40 23 10

### PROCESS WATER AND WASTE PIPING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Process water and waste piping and fitting materials.
  - 2. Installation of process piping and fittings.
  
- B. Related Sections:
  - 1. Section 09 97 20 - Coatings for Industrial Facilities
  - 2. Section 40 23 00 - Process Piping General Provisions
  - 3. Section 40 23 30 - Process Piping Specialties
  - 4. Section 40 23 40 - Process Piping Hangers and Supports
  - 5. Section 40 23 50 - Process Piping Testing, Adjusting, and Disinfection

##### 1.02 REFERENCES

- A. ASTM:
  - 1. D1785 - Specification for PVC Pipe, Schedules 40, 80, and 120
  - 2. D2464 - Specification for Threaded PVC Pipe Fittings, Schedule 80
  - 3. D2467 - Specification for PVC Pipe Fittings, Schedule 80
  - 4. D2564 - Specification for Solvent Cements for PVC Piping Systems
  
- B. AWWA:
  - 1. C104 - American National Standard for Cement - Mortar Lining for Ductile Iron Pipe and Fittings for Water
  - 2. C110 - Standard for Ductile Iron and Gray Iron Fittings for Water
  - 3. C111 - Standard for Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
  - 4. C115 - Standard for Flanged Ductile Iron Pipe and Ductile Iron or Gray Iron Threaded Flanges
  - 5. C150 - Standard for Thickness Design of Ductile Iron Pipe
  - 6. C151 - Standard for Ductile Iron Pipe, Centrifugally Cast, for Water
  - 7. C153 - Standard for Ductile Iron Compact Fittings for Water Service
  - 8. C606 - Standard for Grooved and Shouldered Joints

##### 1.03 SUBMITTALS

- A. Submit Shop Drawings for:
  - 1. Location and style of all pipe hangers, supports and anchors.
  - 2. Length of pipe and pipe spools for exposed piping.
  - 3. Detailed piping layout for connection to existing and proposed pipe and equipment.

#### PART 2 PRODUCTS

##### 2.01 MANUFACTURERS

- A. DI Pipe and Fittings:
  - 1. American Cast Iron Pipe Co.
  - 2. U.S. Pipe
  - 3. Approved equals per Article 6.05 of the General Conditions

## 2.02 PIPE

- A. Unless otherwise shown or specified, all interior piping 4 inches in diameter or larger shall be ductile iron conforming to AWWA C151.
- B. Ductile Iron: AWWA C151.
  - 1. Cement-Mortar Lining: AWWA C104.
  - 2. Pressure Class:
    - a. Interior piping: 250 psi.
    - b. Buried Piping: 350 psi.
  - 3. Joints:
    - a. Interior piping:
      - 1) Flanged: AWWA C115.
      - 2) Rigid grooved: AWWA C606.
    - b. Buried piping:
      - 1) Push-on: AWWA C151.
- C. PVC Piping
  - 1. All chemical feed carrier lines shall be constructed of PVC.
  - 2. PVC shall conform to ASTM D1784, Class 12454-B.
  - 3. PVC piping and fittings shall be PVC 1120, Schedule 80 high impact conforming to ASTM D1785 with bells conforming to ASTM D2672. Solvent-weld fittings shall conform to ASTM D2467 and for threaded ASTM D2464.
  - 4. All piping shall be approved for use by the National Sanitation Foundation.
  - 5. All pipe delivered to the jobsite shall be properly marked for type, grade, and design stress rating. Expansion joints shall be provided where needed. In general, all joints shall be solvent-weld, except where flanges are shown on the drawings, or where transition to another pipe material is required. Pipe shall be installed in compliance with ASTM D2321, except as otherwise specified herein.
  - 6. Solvent cement for chemical feed PVC piping shall be specifically designed for chemicals being used. Cement for caustics, sodium hypochlorite, and brine solutions shall be Oatey EP42 CPVC HD Gray Industrial Cement, IPS Corporation Weld-On 724, or equal.
- D. Polyethylene Tubing:
  - 1. Chemical feed tubing shall be polyethylene tubing, unless otherwise shown or specified.
  - 2. All tubing bends, tees, adapters and unions shall be clear polypropylene compatible with the tubing and solution, or equal.
  - 3. Tubing inserts shall be used at all fittings. Tubing and fittings shall be rated for operating pressures of 120 psi minimum.
  - 4. Tubing runs in excess of 10 feet shall be run in adequately supported minimum 2-inch ID Schedule 40 PVC conduits.
  - 5. Conduit runs shall be broken at all fittings and bends to allow easy access to interior tubing. Conduit shall be supported as specified for PVC piping.
  - 6. Conduits shall include caps on each end with holes sized for interior PE piping to enter and exist as needed.
- E. Copper (Process Related)
  - 1. Copper piping shall conform to the requirements of the Specifications for Seamless Copper Water Tube, ASTM B88.
  - 2. Unless otherwise shown or specified, all interior or aboveground potable and nonpotable water supply piping 3 inches in diameter or smaller shall be Type K hard copper.
  - 3. Fittings shall be soldered or sweated on and shall be of cast bronze or forged brass containing 85 percent copper.
  - 4. All underground water supply piping 3 inches or smaller shall be Type K soft copper with compression fittings. Joints shall not be used under floor slabs.
  - 5. Shutoff valves shall be placed on each branch for all underground, aboveground, or
  - 6. interior piping.
  - 7. Pump vent and drain lines and lines to pressure gauges above the floor shall be rigid Type K hard copper. An ample number of unions shall be provided for disassembling.

8. Pump vents shall be valved.

### **2.03 FITTINGS**

- A. Ductile Iron: AWWA C153.
  1. Cement-Mortar Lining: AWWA C104.
  2. Joints:
    - a. Flanged: AWWA C110.
    - b. Mechanical: AWWA C111.
- B. PVC: Schedule 80.
  1. Threaded: ASTM D2464.
  2. Socket: ASTM D2467.
    - a. Solvent Cement: ASTM D2564.

### **2.04 ANCHOR BOLTS AND NUTS**

- A. Interior Fittings: Zinc coated steel.
- B. Submerged and Buried Fittings: 304 stainless steel.

### **2.05 COATINGS**

- A. Encased or Buried Pipe:
  1. Asphaltic coating per AWWA C151.
  2. Minimum Thickness: 1 mil.
- B. Interior Pipe:
  1. 2-component shop prime.
  2. Final coat per Section 09 97 20.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Provide piping in accordance with Section 40 23 00 and as shown on the Contract Drawings.
- B. Install vertical piping runs plumb and horizontal runs parallel with structure wall unless otherwise noted on the Drawings.
- C. Alignment for piping smaller than 4 inches may not be shown on Drawings. Install with clearance and allowance for:
  1. Expansion and contraction.
  2. Operation and access to equipment, doors, windows, hoists, and moving equipment.
  3. Headroom and walking space for working areas and aisles.
  4. System drainage and air removal.
- D. Provide full force gaskets on all systems.
- E. Fit flange joints so contact faces bear uniformly on gasket. Ensure uniform bolt stress when tightened.
- F. Bolts shall not extend more than 0.5-inch beyond the nut for all applications.
- G. Provide hangers and supports in accordance with Section 40 23 40.

**END OF SECTION**



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## SECTION 40 23 20

### PROCESS PIPING VALVES AND OPERATORS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Process piping valves.
  - 2. Process piping valve accessories.
  - 3. Process piping valve installation.
  
- B. Related Sections:
  - 1. Section 40 23 00 - Process Piping General Provisions
  - 2. Section 40 23 10 - Process Water and Waste Piping
  - 3. Section 40 92 40 - Process Valve Actuators

##### 1.02 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 - Submittal Procedures the following items:
  - 1. Product data
  - 2. Dimensions
  - 3. Manufacturer recommendations for installation

#### PART 2 PRODUCTS

##### 2.01 MATERIAL

- A. Size, joint type, and body material of process valves shall correspond to the size, joint type, and material of adjacent piping, unless otherwise stated on Contract Drawings and specifications.

##### 2.02 EQUIPMENT

- A. Gate Valves (3-inch or larger):
  - 1. Valves shall be resilient seated gate valves conforming to the latest revision of AWWA standard C-509.
  - 2. Valves shall be non-rising stem, opening by turning stem left and provided with a handwheel, unless otherwise shown or specified, and the word "open" and an arrow cast in the metal to indicate direction to open.
  - 3. The wedge shall be cast iron completely encapsulated, except for guide and stem nut areas, with polyurethane rubber.
  - 4. The polyurethane sealing rubber shall be permanently bonded to the cast iron wedge to meet ASTM tests for rubber to metal bond ASTM D429.
  - 5. Stem shall be cast bronze with integral collars in full compliance with AWWA standards. The stem stuffing box shall be the O-ring seal type with two O-rings located above the thrust collar. The two O-rings shall be replaceable with valve fully open and subjected to full rated working pressure.
  - 6. Provide two low torque thrust bearings located above and below the stem collar. The stem nut shall be independent of wedge and shall be made of solid bronze.
  - 7. There shall be a smooth unobstructed waterway free of all pockets, cavities and depressions in the seat area.
  - 8. The body and bonnet shall be coated on the interior and exterior with fusion bonded epoxy.
  - 9. Each valve shall have manufacturer's name, size, pressure rating, and year in which manufactured cast on the body.
  - 10. Prior to shipment from factory, each valve shall be tested by hydrostatic pressure equal to twice the specified working pressure.

11. Approved Manufacturers: Clow, American, Mueller, M&H, or approved equal.

B. Butterfly Valves:

1. Butterfly valves 3-inch through 30-inch shall have flanged ends and meet or exceed the requirements of AWWA C504 Class 150B and MSS SP-67.
2. Valve body shall be ASTM A126 Class B cast iron.
3. Disc:
  - a. 3-inch to 20-inch valves: The disc shall be a lens-shaped design to afford minimal pressure drop and line turbulence. Materials of construction shall be:
    - 1) 3-inch to 6-inch: ASTM A351 gr. CF8N stainless steel disc
    - 2) 8-inch to 20-inch: ASTM A126, Class B cast iron disc with a stainless steel Type 316 edge
  - b. 24-inch and larger valves: All valve discs shall be constructed of ductile iron ASTM A536 with a stainless steel seating edge. The disc shall not have any hollow chambers that can entrap water. All surfaces shall be visually inspected and measurable to assure all structural members are at full disc strength. Disc and shaft connection shall be made with stainless steel pins.
4. Valve stem shall be 304 stainless steel and shall be supported on upper and lower nylon bearings.
5. Seat and stem seals shall be acrylonitrile-butadiene.
6. The seat shall be compression molded in the body and shall conform to ASTM D429 test standards.
7. All process butterfly valves throughout the treatment facility shall be by the same manufacturer. Contractor shall coordinate with fabricated gravity filter supplier.
8. Operators
  - a. Hand levers shall be provided for all 4-inch and smaller butterfly valves. Hand levers shall be directly connected to the shaft, parallel to the disc, and shall rotate 90° from full open to tight close. Unless otherwise noted, levers shall include a locking device to assure positive disc position in the open, closed and at least 8 intermediate positions around the quadrant of rotation.
  - b. Handwheel operators shall be provided for all 6-inch and larger butterfly valves. Valves with centerlines more than 6 feet above the floor shall be equipped with chain wheels and chains. Handwheel operators (geared actuators) shall be furnished with a 2-inch AWWA nut, cast iron handwheel. Handwheels shall have a maximum diameter of 12 inches. The operator shall be capable of throttling the valve in any position and holding this position under all operating conditions. The unit shall be of the worm screw or traveling nut type, totally enclosed, operating in a lubricant. Exterior position indication shall be provided. Maximum handwheel or chainwheel pull shall be 80 pounds at the rim.
  - c. Handwheel floorstand operators and torque tubes shall be provided for valves as shown on the drawings. The floorstand operators shall include position indicators and geared actuators. Henry Pratt Diviner Handwheel Floorstand or equivalent by Dezurik.
  - d. All butterfly valves shall be provided with position indicators.
  - e. Provide electric or pneumatic actuators where shown on the drawings in accordance with the Pneumatic Actuators article of this section or Section 40 92 40.
  - f. Provide torque tubes, extension bonnets, u-joints, steady bearings, wall brackets, and extension shafts as shown on the drawings and required for a complete functioning system. Items shall be manufactured by Henry Pratt Company or equivalent by Dezurik.
  - g. Provide extended necks with wall brackets where shown on the Drawings. The extended neck shall be made of an interior 6-inch diameter schedule 80 steel pipe, with the exterior being made of 8-inch schedule 40 pipe. Extended neck braces shall consist of drill-in type anchor bolts with galvanized or stainless steel pipe supports.
9. All process butterfly valves throughout the treatment facility shall be by the same manufacturer.
  - a. In-plant butterfly valves shall be Pratt 2FII by Plant and Flanged, Pratt Triton XR-70 by Plant and Flanged, or DeZurik BAW. No substitutes.
  - b. Buried butterfly valves shall be Pratt Groundhog or DeZurik BAW.
  - c. Buried valves shall have an AWWA nut and valve box.

C. Swing Check Valves (Air Cushioned)

1. The swing check valve shall be constructed with heavy cast iron or cast steel body with a bronze or stainless steel seat ring, a non-corrosive shaft for attachment of weight and lever, and complete non-corrosive trim cushion chamber. Body shall have minimum 175 psi pressure rating and shall be provided with ANSI standard 125-pound flanges.
2. Valve shall absolutely prevent the return of water, soil, or gas back through the valve when the inlet pressure decreases below the deliver pressure. The valve must be tight seating, and must be cushioned in operation. The seat ring must be renewable.
3. The cushion chamber shall be of bronze construction and the shock absorption by air. The cushion chamber shall be attached to the side of the valve body externally and so constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The cushion chamber shall be arranged that the closing will be adjustable to meet the service requirements.
4. The valve disc shall be convex and of cast iron or cast steel and shall be suspended from a non-corrosive shaft which will pass through a stuffing box and be connected to the cushion chamber on the outside of the valve.
5. All material and workmanship shall be first class throughout and the purchaser reserves the right to inspect this valve before shipment.
6. Air cushioned swing check valves shall be Golden Anderson Figure No. 250-D, or APCO Series 250.

D. Plastic Ball Valves:

1. Furnish true union manually operated ball valves in PVC construction.
2. Valves shall have lever operators unless otherwise noted.
3. Ball valves as manufactured by Chemtrol, or equal, and which meet these specifications will be accepted.

E. Plug Valves:

1. In-Plant Plug Valves - General:
  - a. Valves on sludge, sewage and water shall be non-lubricated eccentric type with resilient-faced plugs. Valves shall be operated by nuts, or cast iron handwheels or chainwheels as indicated on the Drawings. Operators whose center line is 6'-6" or higher above the operating floor, shall be equipped with galvanized shrouded pocket handwheels and sherardized chains. Bolt-on chainwheels for mounting on standard handwheels will not be acceptable. Handwheels and chainwheels shall have a maximum diameter of 12 inches. Maximum handwheel or chainwheel pull shall be 80 pounds at the rim.
  - b. All valves, except those indicated on the Drawings, shall be equipped with gear actuators. All bearing surfaces shall be enclosed, suitable for running in oil or grease with seals provided on all shafts to prevent entry of dirt and water into the actuator. Actuator shall clearly indicate valve position and an adjustable stop shall be provided to set closing. Valve packing adjustment on non-submerged valves having adjustable packing shall be accessible without removing the actuator from the valve. Construction of actuator housing shall be cast iron or semi-steel. All exposed nuts, bolts, and washers shall be zinc-plated.
  - c. Provide pneumatic actuators where shown on the Drawings in accordance with Section 40 92 40.
  - d. Certified copies of proof-of-design test reports shall be furnished in accordance with AWWA C504, Section 5.2.

F. Air Release and Air Release/Vacuum Breaker Valves

1. General:
  - a. Air release valves, air/vacuum release valves and combination air valves shall conform to AWWA C512 and be manufactured by APCO Valve Corporation; Val-Matic; Crispin; or equal.
  - b. Body, cover and baffle shall be cast or ductile iron. Fasteners, internal linkage, internal parts, floats, and float guide shall be stainless steel. Elastomers shall be Buna-N.
  - c. All valves shall be furnished with an inlet shut-off ball valve. Discharge lines shall extend down to 18 inches above the floor.

- d. Valves on sewage lines shall be equipped with backflushing attachments consisting of a 1-inch blow-off valve, shut-off valve, and quick disconnect coupling and a minimum of 6 feet of back-flushing hose.
  - e. Add a pipe saddle if valve and pipe tap size required for flow condition are too large to allow adequate thread depth.
  - f. Venting rate and size for all valves shall be within the manufacturer's recommendations.
2. Air Release Valves
- a. Air release valves shall allow entrained air in pipelines to escape through an air release orifice. After entrained air escapes, the valve orifice shall close by a needle mounted upon a compound lever mechanism actuated by a float. Air release shall remain closed until more air accumulates and the opening cycle is repeated.
  - b. Water valves shall be APCO Series 200, Val-Matic (Model 38, 45, or 50), or equal.
  - c. Sewage air release valves shall be APCO Series 400 or equal.
3. Air Release/Vacuum Breaker Valves:
- a. Design valve to exhaust air from well pump column piping upon pump startup, and allow air to re-enter column piping when pump shuts down.
  - b. Water valves shall be APCO Series 140, Val-Matic (Model 100, 101, or 102).
  - c. Equip with adjustable throttling device to regulate flow of air escaping during pump startup.
4. Combination Air Valves:
- a. Combination air valves shall be a single housing style that combines the operating features of an air release/vacuum breaker valve, as well as an air release valve when the system is under pressure.
  - b. Water valve shall be APCO Model 143C, 145C, 147C, 149C, 150C, or 151C, Val-Matic Series 200, or equal.
- G. Sample Taps - Water Only:
- 1. Sample cocks shall be mounted where shown on Drawings.
  - 2. Sample taps for water shall be constructed of brass. They shall be suitable for bacteriological testing and have no internal threads, screens, aerators, external threads at the discharge, or other small areas that would encourage bacterial growth.
  - 3. The main body shall be a one-piece, angle pattern globe valve with an integral MPT pipe connection, a hex nut, and a smooth-nose discharge. The seat seal shall be rubber. The operating knob shall be round, at least 1.25-inch diameter, replaceable, and constructed of plastic or metal.
    - a. For pressures <80 psi, provide 1/2-inch chrome-plated smooth-end sampling cock, Zurn Z-80401, or equal.
    - b. For pressures >80 psi, provide 1/2-inch satin brass smooth-end sample cock, Conbraco 26-314, or equal.
- H. Valve Tags & Equipment Tags:
- 1. Valve Tags: All new valves and major process equipment shall be tagged. CONTRACTOR shall furnish and install on valves, engraved 2 1/2-inch by 2 1/2-inch plastic laminated tags, Seton "Setonply Series M4550-H," or equal.
  - 2. Nomenclature for tagging (letters and numbers) will be provided by ENGINEER.
  - 3. Colors will be selected by OWNER.
  - 4. CONTRACTOR shall affix tags to valves with Brady 3809, or equal, stainless steel wire and Brady 38090, or equal, zinc wire clamps.
  - 5. Tags shall be engraved plastic. Plastic shall be three colored layers. Engraving shall reveal the inner, contrasting color. Lettering shall be 1/2-inch high minimum. Unless otherwise noted, use black tags with white lettering.
- I. Pipe Labels
- 1. Manufacturers: Marking Systems, Inc., Seton Name Plate Company, W.H. Brady Company, or equal.
  - 2. Pipe markers shall conform to ANSI A13.1. Arrow markers must have same ANSI background colors as their companion pipe markers or be incorporated into the pipe identification marker.
  - 3. Plastic Pipe Markers: Factory-fabricated, flexible, semirigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

4. Pipe markers and arrow markers also shall be provided for all piping systems.
5. Use Seton Setmark type SNA or Brady Snap-on type identification for all piping systems, up through 6 inches.
6. For piping systems larger than 6 inches, use Seton or Brady strap-on markers, or similar, by Marking Services, Inc. Self-adhesive labels are not acceptable. Provide lettering in accordance with information below:

<b>Outside Pipe Dia. (Including Covering)</b>	<b>Minimum Length of Label Field (Inch)</b>	<b>Minimum Height of Letters (Inch)</b>
3/4 inch to 1-1/4 inch	8	1/2
1-1/2 inch to 2 inch	8	3/4
2-1/2 inch to 6 inch	12	1-1/4
8 inch to 10 inch	24	2-1/2
Over 12 inches	32	3-1/2

- J. Rubber Flapper Swing Check Valves:
  1. Manufacturer: APCO Series 100.
  2. Provide on discharge of sludge and recycle pumps as shown on Drawings. Provide two 4-inch valves and two 6-inch valves.
  3. Materials and Construction:
    - a. Cast Iron Body.
    - b. Tight Sealing.
    - c. O-ring Seating.
    - d. Buna-N Coated Steel Disc.
    - e. Manual Back Flushing Hold-Open Device.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Inspect all material and equipment as it is received to determine damage and/or missing parts. Repair or replace damaged items in accordance with the manufacturer's instructions.

### **3.02 INSTALLATION AND TESTING**

- A. Each item or system shall be furnished complete and installed as shown on the drawings and in accordance with the manufacturer's recommendations, instructions and directions. The complete installation shall function properly and reflect a high work quality.
- B. Refer to related sections of this specification for additional installation and testing requirements and information. Tests shall be conducted after all valves are installed.

### **3.03 PAINTING**

- A. The exterior of all valves, operators, and accessories, unless otherwise described, shall be painted as specified under Section 09 91 00. Valves shall be painted to match the color of the adjacent piping.

### **3.04 OPERATOR TRAINING**

- A. Provide minimum of 2 hours of operator training, for each type of actuator function (electric or pneumatic) included in the Project. Schedule training at Owner's convenience, after system is operational.

### **3.05 VALVE SCHEDULE**

- A. Reference Sheet 01-P901 in the Drawings for the Project Valve Schedule.

- B. The Valve Schedule has been included for the purposes of conveying information regarding operator requirements for some of the valves to be installed as part of this project.

**END OF SECTION**

## SECTION 40 23 30

### PROCESS PIPING SPECIALTIES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Miscellaneous process piping items.
- B. Related Sections:
  - 1. Section 40 23 00 - Process Piping General Provisions
  - 2. Section 40 23 10 - Process Water and Waste Piping

##### 1.02 REFERENCES

- A. ASTM:
  - 1. C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
  - 2. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005
  - 3. E96 - Standard Test Methods for Water Vapor Transmission of Materials; 2000
- B. NFPA:
  - 1. 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; 2006
- C. UL:
  - 1. 723 - Standard for Test for Surface Burning Characteristics of Building Materials, 2003

##### 1.03 SUBMITTALS

- A. Submit Product Data which includes the following for each item furnished:
  - 1. Manufacturer and model.
  - 2. Component materials.
  - 3. Dimensions.
- B. Seal Installation Through Fire-rated Wall, Roof, or Floor:
  - 1. Provide Engineer and Code Official with 2 copies each of proposed firestop system for each pipe penetration.
  - 2. System information shall include:
    - a. UL system numbers.
    - b. F and T ratings.
    - c. Detailed drawing.
    - d. Manufacturer name.
    - e. Installation procedure.
    - f. List of components.

#### PART 2 PRODUCTS

##### 2.01 EXPANSION JOINTS

- A. EPDM or Teflon single-filled arch spool type.
- B. Full face steel flanges.



- C. Temperature Range: 40 to 100 degrees F.
- D. Design for UV exposure.
- E. Maximum Working Pressure: 125 psi.
- F. Furnish tie rods, limiter sleeves, and retaining brackets where indicated on Drawings.
- G. Acceptable Manufacturers:
  - 1. Proco Products, Inc.
  - 2. Red Valve Co., Inc.
  - 3. Approved equals.

## **2.02 PRESSURE GAGES AND COCKS**

- A. Pressure Gage:
  - 1. Size: 4-1/2 inch dial.
  - 2. Range: 0-160 psi, unless shown on Drawings.
  - 3. Graduation: 2 psi.
  - 4. Accuracy: 1/2 percent.
  - 5. Movement: Heavy-duty stainless steel.
  - 6. Case: Fiberglass Reinforced Polypropylene.
  - 7. Mounting: Direct (stem).
  - 8. Connection: 1/4-inch NPT, bottom.
  - 9. Glycerin - filled.
  - 10. Manufacturer: Weksler AY04 or approved equal.
- B. Isolation Cock:
  - 1. Ball valve.
  - 2. Suitable to 200 psi.
  - 3. 1/4-inch NPT male and female connections.

## **2.03 PIPE COUPLINGS**

- A. Sleeve type.
- B. Furnish to match pipe being coupled.
  - 1. Size.
  - 2. Material.
  - 3. Pressure.
  - 4. Service of pipe.
- C. Acceptable Manufacturers/Models:
  - 1. Dresser, Style 38.
  - 2. Smith Blair, Type 411.
  - 3. Approved equal.

## **2.04 FLANGED ADAPTERS**

- A. Furnish to match the pipe being connected:
  - 1. Size.
  - 2. Material.
  - 3. Pressure.
  - 4. Service of pipe.

- B. Acceptable Manufacturers/Models:
  - 1. EBBA Iron Series 2100 Megaflange.
  - 2. Dresser, Style 127.
  - 3. Smith Blair, Type 911.
  - 4. Approved equal.

## 2.05 PIPE SLEEVES

- A. Material: Steel Pipe.
  - 1. Furnish zinc-coated steel pipe in the following installations:
    - a. Masonry walls and floor.
    - b. Fire-rated gypboard partitions.
    - c. Masonry or steel deck roofs.
  - 2. Furnish zinc-coated sheet steel in the following installation:
    - a. Non fire-rated gypboard partitions.
- B. Size:
  - 1. Minimum: 2 nominal pipe sizes larger than respective pipe.
- C. Acceptable Manufacturers/Models:
  - 1. American Cast Iron Pipe, Model A-01770.
  - 2. Approved equal.

## 2.06 SEALS

- A. Furnish positive hydrostatic pipe link seal.
  - 1. Sealing Element: Synthetic rubber material expanded by tightening of zinc galvanized plate carbon bolts.
- B. Acceptable Manufacturers:
  - 1. Thunderline Corp.
  - 2. Approved equal.

## 2.07 WALL PIPES

- A. Material: Ductile iron.
- B. Size and End Connections: Match adjacent pipe.
- C. Furnish with welded or integrally-cast waterstop collar.
- D. Acceptable Manufacturers:
  - 1. Clow Pipe.
  - 2. American Cast Iron Pipe.
  - 3. Approved equal.

## 2.08 FLOATING SUCTION STRAINERS AND HOSES

- A. Contractor shall furnish and install a floating suction strainer in each backwash reclaim tank.
  - 1. Dimensions of tank are shown in contract drawings.
- B. Approved Manufacturer:
  - 1. Megator Corporation Dolphin Floating Suction Strainer.
  - 2. Pureflow Filtration Division Floating Decanter System.
- C. Provide two 4-inch suction strainer with a minimum capacity of 300 gallons per minute for installation in the rehabilitated lagoon.

- D. Materials and construction:
  - 1. Stainless steel construction.
  - 2. Floating chamber of polyurethane foam.
  - 3. Freely turning tube to prevent hose from twisting.
  - 4. Eye for providing mooring or for attaching weight.
  - 5. Anti-vortex plates.
- E. Non-floating hose:
  - 1. Approved Manufacturer: Dayco U-10 non-floating hose or Engineer approved equal.
  - 2. Floating suction strainer manufacturer shall provide 20-feet of hose.
  - 3. Cut hose to fit during installation.
  - 4. Hose shall connect to 4-inch DIP flange.
- F. Contractor shall fabricate a cable system to keep floating suction from drifting and to allow vertical movement of flexible hose.

## **2.09 SPRAY NOZZLES**

- A. Approved Manufacturers:
  - 1. Spraying Systems Company, Wheaton Illinois.
  - 2. Or Engineer approved equal.
- B. Materials and Construction.
- C. Uni-Let Model 1/4 TT4060 brass nozzles:
  - 1. Qty: As called for in the Drawings.
- D. Uni-Let Model 1/4 TT1560 brass nozzles:
  - 1. Qty: As called for in the Drawings.
- E. Provide the following nozzles assembly for each nozzle listed above:
  - 1. Nozzle body.
  - 2. Spray tip.
  - 3. Tip retainer.
  - 4. No. 5540 swivel assembly.
- F. In general, installation of the spray wash nozzles is as described:
  - 1. The head end of the tanks, are the shallow ends and the hopper end is the deep end of the tanks.
  - 2. Along the head ends of the tanks, four (4) 1560 type nozzles are to be installed in the center of the tanks along the springline (equator) of the spray wash pipe.
  - 3. Four (4) 1560 type are to be installed on the bottom of the head end pipe, two near the pipe center pointing in toward the center of the head end of the tank, and two installed near the corner 90's oriented in the same manner.
  - 4. Along the long sides of the tanks, 1560 type nozzles are to be installed along the bottom of the spray wash pipes at 6 feet - 0 inch spacing starting 6 inches away from the head end 90's.
  - 5. Along the spring-lines of the long side pipes, 4060 type nozzles are to be installed where spacing is greater than 6 inches on center.
  - 6. Use 1560 type nozzles at the head of the tanks where nozzles are spaced at 6 inches on center.
  - 7. The spring-line nozzle spacing notes are identified per one side of the tank and apply equally to all long sides.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. General:
  - 1. Install all items in accordance with manufacturer's recommendations.
  - 2. Install items only where indicated on the Drawings.

3. Installation at other location only with prior approved by the Engineer.
- B. Pipe Sleeves:
1. Sleeve each pipe individually.
  2. Floor Installation: Extend sleeve 2 inches above finished floor.
  3. Roof Installation:
    - a. Extend sleeve from 4 inches below to 12 inches above roof deck.
    - b. Furnish with welded attachment brackets.
    - c. Furnish with weather skirt for each sleeve.
  4. Provide continuously welded waterstop collar on sleeves set in masonry or concrete.
- C. Seals:
1. Installation through fire-rated wall, floor, or roof.
  2. Seal annular space between piping and sleeve with approved brand fire barrier caulk or putty.

**END OF SECTION**

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## SECTION 40 23 35

### PIPING AND EQUIPMENT IDENTIFICATION

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Work Included: Perform all work required to furnish and install equipment, valve, pipe, and wire identification with supplementary items necessary for proper installation as specified herein, or shown on the drawings. CONTRACTOR shall identify all equipment, valves, piping, ductwork, and wires.
- B. Related Sections and Divisions: Applicable provisions of Division 1 shall govern work in this section.

##### 1.02 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Section 01 30 00 Submittals.
- B. Schedule:
  - 1. Submit valve schedule complete with building number, room number, valve tag numbering system, valve function, valve type, area served, year installed, manufacturer, model number, size, rated pressure, temperature rating and normal position.
  - 2. Valve schedule shall be developed using OWNER's valve naming convention. Provide OWNER with electronic version (Microsoft Excel) of the final approved valve schedule at or before Project closeout.

##### 1.03 REFERENCES

- A. All material, installation, and workmanship shall comply with the applicable requirement and standards addressed within the following references:
  - 1. ASME A13.1–Scheme for the Identification of Piping Systems
  - 2. NFPA 13–Installation of Sprinkler Systems
  - 3. NFPA 14–Installation of Standpipe and Hose Systems.
  - 4. SPS 382 Wisconsin Plumbing Code.

#### PART 2 PRODUCTS

##### 2.01 NAMEPLATES

- A. Type "A" Nameplates:
  - 1. Use: Fans.
  - 2. Fan coil units.
  - 3. Unit heaters, dehumidifiers, etc.
  - 4. Size: 4 inch by 4 inch.
  - 5. Material: 3-layer laminated Micarta. Background Color: Black.
  - 6. Character Color: White. Character Size: 2 1/4 inches. Engraving: Equipment label.
  - 7. Mounting Location: Equipment–Top wireway.
- B. Type "B" Nameplates:
  - 1. Use: Identify thermostats, etc. Size: 3/8 inch by 2 inch.
  - 2. Material: 3-layer laminated Micarta. Background Color: Black.
  - 3. Character Color: White. Character Size: 1/8 inch.
  - 4. Engraving: Control station number or equipment controlled. Mounting Location: Device front at top.

## 2.02 LABELING TAGS

- A. Valve Tags: All new valves shall be tagged. CONTRACTOR shall furnish and install on valves, engraved 2 1/2-inch by 2 1/2-inch plastic laminated tags, Seton "Setonply Series M4550-H," or equal. Nomenclature for tagging (letters and numbers) will be provided by ENGINEER. Colors will be selected by OWNER. CONTRACTOR shall affix tags to valves with Brady 3809, or equal, stainless steel wire and Brady 38090, or equal, zinc wire clamps.

## 2.03 PIPE MARKERS

- A. Manufacturers: Marking Systems, Inc., Seton Name Plate Company, W.H. Brady Company, or equal.
- B. Pipe markers shall conform to ANSI A13.1. Arrow markers must have same ANSI background colors as their companion pipe markers or be incorporated into the pipe identification marker.
- C. Plastic Pipe Markers: Factory-fabricated, flexible, semirigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Pipe markers and arrow markers also shall be provided for all piping systems.
- E. Use Seton Setmark type SNA or Brady Snap-on type identification for all piping systems, up through 6 inches. For piping systems larger than 6 inches, use Seton or Brady strap-on markers, or similar, by Marking Services, Inc. Self-adhesive labels are not acceptable. Provide lettering in accordance with table below.

PIPE MARK SIZE CHART

Outside Pipe Diameter (Including Covering)	Minimum Length of Label Field Color (Inch)	Minimum Height of Letters (Inch)
3/4 inch to 1 1/4 inch	8	1/2
1 1/2 inch to 2 inch	8	3/4
2 1/2 inch to 6 inch	12	1 1/4
8 inch to 10 inch	24	2 1/2
Over 10 inch	32	3 1/2

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state, and local requirements and referenced standards and conform to code and ordinances of authorities having jurisdiction.
- B. Degrease and clean surfaces to receive nameplates.
- C. Install nameplates parallel to equipment lines.
- D. Affix nameplates with stainless steel screws or sticky-back adhesive.
- E. Prepare and install neatly typed directions in all panels where work is done under this Contract.

### 3.02 PIPE MARKERS

- A. Install pipe markers in accordance with manufacturer's instructions.
- B. Install in clear view and align with axis of piping.

- C. All pipes shall be labeled with a minimum of two labels in each room, crawl space, or compartment. Locate identification at maximum 20-foot centers on straight runs, including risers and drops adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Labels shall be abbreviated as noted under fluid abbreviations on drawings.
- D. All piping containing or transporting hazardous or corrosive chemicals shall be identified with labels every 10 feet and with at least two labels in each room, closet, or pipe chase.
- E. Labels shall identify fluid being conveyed and include flow direction arrow. Provide a double-ended arrow marker when flow can be in either or both directions.
- F. Indicate delivered water temperature on domestic hot water supply and return lines.
- G. CONTRACTOR shall include a schedule in its submittal identifying the various pipe designations, abbreviations, and labeling scheme. Colors, text, and piping abbreviations are to be selected by OWNER, with the following piping marker scheme used where applicable.

Pipe	Label Colors (Background/Text)
<b>Water Lines</b>	
Nonpotable water	Green/White
Potable water	Green/White
Raw	Green/White
<b>Chemical Lines</b>	
Chlorine (gas and solution)	Orange/Black
Fluoride	Orange/Black

Pipe	Label Colors (Background/Text)
<b>Other Lines</b>	
Condensate	Blue/White
Fire Protection	Red/White
Plumbing drains and vents	Green/White

**END OF SECTION**



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## SECTION 40 23 40

### PROCESS PIPING HANGERS AND SUPPORTS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Supports, hangers, anchors, and guides for process piping, valves, equipment, and accessories.
- B. Related Sections:
  - 1. Section 09 97 20 - Coating Systems for Industrial Facilities
  - 2. Section 40 23 00 - Process Piping General Provisions
  - 3. Section 40 23 10 - Process Water and Waste Piping

##### 1.02 REFERENCES

- A. Manufacturer's Standardization Society:
  - 1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture
  - 2. SP-69 - Pipe Hangers and Supports - Selection and Application
  - 3. SP-89 - Pipe Hangers and Supports - Fabrication and Installation
- B. ANSI Code for Pressure Piping B31.1.0.

##### 1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
  - 1. Support piping systems in all conditions of testing and operation.
  - 2. Provide supports that will not become disengaged by movement of the supported pipes.
  - 3. Support System Factor of Safety: 3 based on supported pipe filled with water.
  - 4. Provide means of vertical adjustment after installation.
  - 5. Provide suitable linkage to permit swing at hanger locations where lateral or axial movement is anticipated.
  - 6. Do not support piping from wood or metal truss roof systems unless systems have been specifically designed for such loading.
  - 7. Size hangers to accommodate pipe covering and jacketing on insulated pipe.
  - 8. Provide support to resist flotation of empty pipe when located in submerged areas.
- B. Performance Requirements:
  - 1. Support systems shall prevent movement of the piping in any direction due to pressure, temperature, flow, or water hammer except at properly located expansion joints and fittings.
  - 2. Support piping in a manner to prevent undue strain on equipment, valves, and fittings.

##### 1.04 SUBMITTALS

- A. Provide manufacturer's Product Data for all proposed hangers and supports.
- B. Provide Shop Drawings for all specially designed hanger assemblies and fabrications.
- C. Provide calculations indicating the load at each support location.
- D. Provide Shop Drawings indicating the proposed device at each support location.

## 1.05 QUALITY ASSURANCE

- A. Conform to ANSI B31.1.1.0 except where modified by the Contract Documents.

## 1.06 SEQUENCING AND SCHEDULING

- A. Proceed with the installation of support equipment only after the respective building structural work has been completed and approved and any associated concrete support structure has reached its 28-day compressive strength.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Support process piping from structural elements with adjustable hangers.
- B. Hanger Rods: Subject to tensile loading only.
- C. Pipe hangers and supports shall be fabricated from:
  - 1. Galvanized steel, hot-dipped after fabrication.
  - 2. 304 stainless steel.

### 2.02 MANUFACTURED UNITS

- A. Provide the units indicated for the following applications:
  - 1. Hangers for Ductile Iron, Steel, or Plastic Piping 3 Inches and Larger.
    - a. Anvil Figures 45, 104, 171, and 260.
    - b. Equivalent units by:
      - 1) Cooper.
      - 2) PHD.
  - 2. Adjustable Pipe Saddle Supports for Process Piping on Structural Slabs for Ductile Iron, Steel, or Plastic Piping 3 Inches and Larger:
    - a. Anvil Figures 259, 264, and 265.
    - b. Equivalent units by:
      - 1) Copper.
      - 2) PHD.
  - 3. Hangers From New Reinforced Concrete:
    - a. Loadings Under 400 Pounds:
      - 1) Anvil Figure 285.
      - 2) Equivalent units by:
        - a) Cooper.
        - b) PHD.
    - b. Loadings of 400 Pounds to 1,140 Pounds:
      - 1) Universal concrete inserts.
      - 2) Anvil Figure 282.
      - 3) Equivalent units by:
        - a) Cooper.
        - b) PHD.
  - 4. Continuous Slot Inserts:
    - a. Unistrut P3200 Series.
    - b. Power-strut PS-349 Series.
    - c. Halfen Channels 4122 or 4141 Series.
    - d. Inserts shall have working load capacities greater than the pipe hanger loadings.

### 2.03 ACCESSORIES

- A. Anchor Bolts: ASTM A307, Grade A.
  - 1. Standard threads and hexagonal nuts.

2. Galvanized or cadmium plated.
  3. Bolts in Submerged or Exterior Applications: Stainless steel.
- B. Expansion Bolt Anchors:
1. Subject to approval of the Engineer.
  2. Anchors in Submerged or Exterior Applications: Stainless steel.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Install all units in accordance with manufacturer's instructions.
- B. Locate units so that finished piping will not interfere with:
1. Open accesses.
  2. Walkways and platforms.
  3. Future maintenance of equipment.
- C. Group parallel runs of horizontal piping together on trapeze-type hangers where possible.
- D. Install supports to provide specified slope when indicated.
- E. Provide units of the same type and style for adjacent similar piping.
- F. Installation in steel framed structures.
1. Support piping from beam clamps, attachments, or brackets bolted to steel joists or beams.
  2. Verify with Engineer that structural components are capable of carrying the intended load and stresses.
  3. Not permitted.
    - a. Holes drilled in building steel for hanger support rods.
    - b. Bolting to decking or walkways.
- G. Do not install support attachments for loadings over 50 pounds to the underside of hollow core precast planks without the specified approval of the Engineer and precast plank supplier.
- H. Install supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors.
- I. Install supports to facilitate the movement of expansion joints, loops, bends, and similar items.
- J. Approximate support locations are shown on the Drawings for pipes 12 inches and larger. Provide additional supports as required to meet the specific provisions of this section.

### **3.02 INSTALLATION**

- A. Pipe Support Spacing:
1. Locate units and accessories in accordance with minimum defined in MSS SP-58 and 69.
  2. Provide a minimum of 1 support for each length of pipe and at each change of direction or elevation.
  3. Provide additional supports within 3 feet of each joint for every valve, fitting, flow meter, flexible coupling, and all non-rigid joints.
  4. Locate supports in accordance with maximum allowable spacing shown on the schedules at the end of this section.

B. Building Attachments:

1. Support pipe hangers from concrete inserts in reinforced concrete structures as follows:
  - a. Where support rod sizes exceed 7/8-inch in diameter, or where the pipe load exceeds the recommended load for the insert, use 2 inserts with a trapeze-type connecting member below the concrete.
  - b. Submit proposed insert locations to Engineer for approval in a timely manner to provide for placement of concrete.
  - c. Provide reinforcing rods for pipe sizes over 3 inches.
  - d. In areas where the concrete slab will form the finished ceiling, ensure that inserts finish flush with slab surface to make a neat appearance.
  - e. Locate concrete inserts so that total load on insert does not exceed manufacturer's recommended maximum load.
2. Locate attachments to ensure that the total and point loads from the supports do not exceed the design capacity of the supporting structure.
3. Where it is necessary to anchor supports to hardened concrete or completed masonry, use either:
  - a. Epoxy type adhesive anchors.
  - b. Expansion type anchors.
4. For precast concrete plank, drill through concrete plank from below and provide through bolts with square steel plate and nuts.
  - a. Plate shall bear directly upon the top surface of the precast concrete plank.
  - b. Apply all toppings and insulations after installation of support plate assembly.
5. Attach to structural steel members with beam clamps.
6. Do not support piping from other piping.
7. Prevent contact between dissimilar metals.
  - a. Where a concrete or metal pipe support is used, place a 1/8-inch-thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing.
  - b. Cut to fit entire area of contact between pipe and support.
8. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, plastic coated, or by other recognized industry methods.
  - a. Electrician's tape is **not** an acceptable isolation method.

C. Hanger Supports:

1. Adequate to maintain pipe, apparatus, and equipment in proper position and alignment under all operating conditions.
2. Screw adjustable after installation is complete.
3. Provide piping supported from the ceiling with adjustable wrought clevis hangers.
4. All steel work, bolts, nuts, washers, and welding shall conform to the applicable provisions of Division 5.
5. Hanger rods shall be attached to inserts in new concrete slabs.
6. Install individual or continuous slot concrete inserts for use with hangers for piping in the formwork before concrete slabs are poured.
  - a. Furnish inserts with end caps and cardboard closure strips or filled with foam to prevent concrete intrusion.
  - b. Provide all clamping nuts with springs, additional supporting steel and hanger rods required to make the complete installation.
  - c. Concrete inserts shall be hot-dip galvanized after being cut to the necessary lengths and installation of end plates.
  - d. Clamping nuts shall be given an electro-galvanized finish.
7. Where 2 or more horizontal pipes 3-inches or smaller are run on close centers, support on trapeze-type hangers.
  - a. Use Unistrut P1000, Power-Strut, or equal.
  - b. The maximum load per trapeze shall be 200 pound calculated with all pipes full of water and the maximum length shall be 36 inches.
  - c. Minimum rod size shall be 3/8-inch.
8. Use wall brackets for wall-mounted pipe 2 inches and smaller.
9. Provide pipe guides for hanger supported pipe.
  - a. Install guide on each hanger.
  - b. Install at 60 foot centers and no more than 60 feet from an anchor.

- D. Thrust Anchors and Guides:
1. Suspended Piping:
    - a. Center thrust anchors between expansion joints and/or elbows.
    - b. Anchors shall hold pipe securely.
      - 1) Allow for movement at expansion joints.
      - 2) Prevent separation of joints.
  2. Provide thrust anchors as follows:
    - a. Changes in pipe diameter.
    - b. Changes in pipe direction.
    - c. Pipe dead ends.
  3. Provide anchorage whenever bending stress exceed the allowable stress of the pipe.
  4. Wall pipes may be used as thrust anchors.
  5. Provide pipe guides adjacent to sliding expansion joints in accordance with the National Association of Expansion Joint Manufacturers.

### 3.03 SCHEDULES

- A. Maximum allowable spacing of pipe supports:

1. Ductile Iron Pipe :

Pipe Size-Inches	Max. Span Feet
4 and less	6
6 thru 12	8
14 and greater	16

2. Steel and Stainless Steel Pipe:

Pipe Size-Inches	Max. Span Feet
2 thru 4	6
5 thru 10	8
12 and greater	16

3. PVC Pipe:

Pipe Size-Inches	Max. Span Feet
1 1/4 and less	4
1 1/2 thru 3	5
4 and greater	6

4. Copper Pipe:

Pipe Size-Inches	Max. Span Feet
2 1/2 and less	4
3 thru 6	8

**END OF SECTION**

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## SECTION 40 23 50

### PROCESS PIPING TESTING, ADJUSTING, AND DISINFECTION

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Hydrostatic leak testing.
  - 2. Process equipment testing and adjusting.
  - 3. Process system disinfection.
  
- B. Related Sections:
  - 1. Section 40 23 00 - Process Piping General Provisions
  - 2. Section 40 23 10 - Process Piping Water and Waste Piping

##### 1.02 REFERENCES

- A. AWWA:
  - 1. C651 - Disinfecting Water Mains
  - 2. C653 - Disinfection of Water Treatment Plants

##### 1.03 SUBMITTALS

- A. Submit copies of the following test results:
  - 1. Field quality control.
  - 2. Start-up.
  - 3. Disinfection.

##### 1.04 SCHEDULING AND SEQUENCING

- A. Perform leakage testing prior to the application of coatings or insulation on the piping.

#### PART 2 PRODUCTS

Not Used

#### PART 3 EXECUTION

##### 3.01 PREPARATION

- A. Isolate all piping and equipment from potable water systems.
  
- B. Remove foreign materials from the piping and equipment by means of flushing or other appropriate methods.
  
- C. Install taps in pipe as required to expel air prior to hydrostatic testing.

##### 3.02 FIELD QUALITY CONTROL

- A. Leakage Testing:
  - 1. Perform hydrostatic leakage testing on all process piping and equipment as follows:
    - a. Test pressure:
      - 1) Ductile iron pipe: 100 psi.



- 2) Steel pipe: 100 psi.
- 3) PVC pipe: 100 psi.
- b. Test duration: 1 hour.
- c. Allowable pressure drop: None.
2. If pressure drop is detected, determine and correct source of leakage.
3. Re-test until satisfactory results are obtained.

B. Manufacturer's Field Service:

1. Inspect, calibrate, and adjust process equipment and systems prior to start-up.
2. Supervise placement of equipment and systems into operation.
3. Perform final inspection and adjustment to ensure proper operation of the system.

### 3.03 DISINFECTION

- A. Perform disinfection of all process piping and equipment in accordance with the following:
  1. AWWA C651.
  2. AWWA C653.
- B. Hold chlorine solution in pipe for a minimum of 24 hours.
  1. Initial Dosage: 50 ppm minimum.
  2. Residual Dosage After Hold Period: 10 ppm minimum.
- C. Operate all valves and other equipment during disinfection to ensure complete coverage.
- D. Flush system with potable water within 24 hours after disinfection is completed.
- E. After flushing, obtain 2 sets of samples taken a minimum of 24 hours apart.
  1. Take sample sets from various representative areas of the piping.
  2. Minimum Samples Required per set: 2.
- F. Perform coliform and chlorine residual tests on each sample.
- G. Rechlorinate if any samples test positive for coliform.
- H. After satisfactory test results are achieved, the piping may be connected to the potable water system.

**END OF SECTION**

## SECTION 40 90 00

### CONTROL SYSTEM FUNCTIONAL DESCRIPTIONS

#### PART 1 GENERAL

##### 1.01 FUNCTIONAL DESCRIPTIONS - GENERAL SOFTWARE AND PROGRAMMING FEATURES

###### A. General

1. Definitions:
  - a. "PLC" - Programmable Logic Controller
  - b. "MGD" - Million Gallons per Day
  - c. "GPM" - Gallons Per Minute
  - d. "PID" - Proportional-Integral-Derivative
  - e. "PSI" - Pounds per Square Inch

###### B. System overview

1. Contractor shall furnish and install complete, a distributed instrumentation and control system, outside of the PLC and SCADA programming, including field instruments, control panels, programmable logic controller (PLCs), installed in the control panel as specified.
2. All system control logic shall be programmed by the City. This includes the PLC and the SCADA HMI software, and network communications. Successful Control Systems Integrator shall coordinate closely with the City's programmer during design of the control panel.

###### C. System configuration

1. Monitor local HOA control switches for each piece of equipment and display IN AUTO on the computer screens. When in AUTO mode, call for a piece of equipment to operate as required to satisfy its control signal.
2. Furnish and install equipment components and programmable logic controllers (PLCs) as indicated. Equip each PLC with inputs and outputs as indicted, plus 20 percent spare inputs/outputs (DI,DO,AI,AO)of each signal type. Provide each PLC with a rack having enough empty slots for addition of more input/output modules at each PLA as indicted on drawings, minimum of 2 slots.

###### D. System Communications

1. Provide combination Ethernet TCP/IP and fiber optic communication between the fiber panel and PLC. Provide Ethernet TCP/IP communications between PLC panel and devices located in building as indicated on the plans.
2. Alarm if communication is lost with any panel or device on the network(s). Generate a descriptive alarm condition that identifies the sites where communication has been lost.
3. It is the intent of this specification that all system information shall be available to the operators at any of the project PC's and OITs. This requirement will result in a fairly large amount of data being sent between PLC and the SCADA Master. Please take this into consideration when programming the system.

###### E. Analog Value Alarms

1. Allow operator to assign "high" and "low" software setpoints to all analog inputs. If measured value exceeds the high setpoint or falls below the low setpoint, energize an associated alarm at the computer. All displays and software setpoints shall be in engineering units.
2. Analog value alarms shall function as described above for plant alarms.

###### F. Equipment "Fail" Alarms

1. When an equipment item is called to operate, monitor the associated RUNNING contacts. If a RUNNING signal is not returned after five seconds (adjustable), then generate a descriptive alarm point.
2. When a flow signal is available to verify pump operation, then check the flow signal for a differential increase after the pump has started. Provide adjustable flow differential and adjustable

time delay. If the flow increase does not exceed the adjustable value after the time delay, then generate a descriptive alarm point. Provide a software means for the operator to disable this “proof of flow” function for flowmeter maintenance, etc.

G. Miscellaneous Status and Alarm Points

1. The Drawings show several miscellaneous status and alarm points that are not specifically described in these functional descriptions. Graphic screens shall be provided to include all of the status information that is available at the PLCs. Alarms shall be developed for each of the alarm points that are available.

H. Software Control Switch

1. Each piece of equipment controlled via the PLC shall have a software Hand-Off-Auto switch. In the Hand mode, the equipment shall be called to operate. In the Auto mode, the piece of equipment shall be called to operate as described herein. In the Off mode, the equipment shall not be called to operate regardless of the controlling value status. If the equipment should be called to operate based on the controlling logic described, but the equipment is in the Off mode, generate an associated alarm.
2. Provide a computer screen to show the status of the software HOA switch for each piece of equipment.

I. Hardware Control Switch

1. The Drawings indicate hardware Hand-Off-Auto selector switches and other equipment having IN AUTO signals to the plant control system. If the equipment should be called to operate based on the controlling logic described, but the switch (or signal from equipment) is not in the AUTO position, generate an associated alarm.

J. Software Run Time Meters

1. Each piece of equipment with a “Running” contact monitored by the PLC shall have a software Run Time Meter (RTM).
2. Software RTM shall monitor the RUNNING contact and the computers shall display totalized, non-resettable run time in hours and tenths, and runtime for the last 24 hours in hours and tenths.

K. Variable Frequency Drives (VFD)

1. Where variable frequency drives are controlled by the PLC, allow the operator to set maximum and minimum motor speeds. Alarm if a closed-loop setpoint is not maintainable within the motor maximum and minimum speeds. Coordinate with the motor supplier the minimum allowable speed and ramp rates on starting and stopping.
2. Monitor VFD alarm contacts. Generate associate alarm.
3. Monitor and indicate motor speed. Alarm if motor speed running does not agree with the motor speed called while drive is in any Auto mode.
4. Each VFD shall include an HOA switch on the front face of the VFD or at the equipment. PLC shall monitor the “AUTO” position of the switch. When a switch is in the OFF position, the VFD shall not operate for any reason. When a switch is in the HAND position, the VFD shall start and operate based on the local speed entered on the keypad at the VFD. When a switch is in the AUTO position, the VFD shall start and operate as called for from the PLC via a Ethernet speed signal. Allow the operator to adjust the speed signal to each VFD as desired/required.
5. PLC shall monitor a Ethernet speed reference signal from each VFD and shall display the running speed for each VFD.
6. PLC shall monitor the RUNNING, IN AUTO, and ALARM/FAULT output signals from each VFD and shall generate associated alarms. PLC shall send a DO hardwired START start signal to each VFD.
7. PLC shall monitor the local ENABLE contacts that are wired to each VFD and shall generate and associated alarm if a VFD is DISABLED for any condition. (local disconnect status)

L. Valves/Gates

1. Upon sending an OPEN or CLOSE command, the PLC shall monitor the limit switches to verify proper operation. If after 30 seconds (adjustable) the valve/gate has not properly responded, generate an alarm.

2. Upon sending a position signal for modulating valves, the PLC shall monitor the feedback signal to verify proper operation. If after 30 seconds (adjustable) the valve has not properly responded within an adjustable deadband, generate an alarm. Display valve position.
- M. Flowmetering
1. Magnetic type flowmetering shall be furnished under Specification Section 43 22 52.
  2. Each flowmeter system will include a 4-20 mAdc analog output signal for use by the control system for remote monitoring of flow. The 4-20 mAdc flow signal will be linear with flow from the associated pump(s). Confirm flow ranges for the pump(s) with the Owner and Engineer during construction. Input the 4-20 mAdc flow signal to the PLC as indicated on the Drawings. Transmit the instantaneous flow signal to the computers for display on the computer screens.
  3. PLC shall totalize flow by monitoring the discrete output signal from each meter that pulses every 1000 gallons and shall make the information available on the computer screens.
  4. Allow the operator to choose to trend on each flow signal.
  5. Provide computer screens with the following:
    - a. Display of all instantaneous flows (GPM).
    - b. Display of all totalized flows (thousands of gallons).
- N. Pressure level sensing
1. Provide a graphic showing tank being monitored and fluid level.
  2. Trend signals
  3. Provide operator adjustable 'high' and 'low' level alarm points.
- O. Chemical systems
1. Provide graphical representation of chemical systems.
  2. Show scale levels in graphical representation and in digital level. Provide low level alarm.
  3. Where chem pumps modulate, monitor the analog signal from the pump and if it does not correlate with the signal being sent, send alarm.
  4. Display chemical analyzer levels. Provide high and low operator adjustable level alarm points.
  5. Display gas feeder alarms.
- P. Large Equipment Start/Stop Delays
1. Provide software time delays (operator adjustable) to stagger starting and stopping of larger process equipment (greater than 15 HP) if more than one such piece of equipment is called to operate or stop at the same time.
- Q. Control Panel - Control Power Failure, UPS Trouble and UPS Failure Bypass Interlocks
1. Provide digital PLC inputs and monitor the control power available relay provided on the line side of the UPS at each main control panel. Generate associated alarm and display on the computers.
  2. Furnish an oversized UPS in each main control panel with relay card and software for monitoring "UPS Trouble" output contacts as indicated on the Drawings. Furnish and install all necessary interface relays, cables, connectors, etc., for a complete and fully functioning system. Monitor associated alarm and display on the operator interface.
  3. Furnish and install the UPS bypass relaying and interlock scheme as indicated on the Drawings for allowing the PLC control system to function upon UPS failure.
  4. The control power and UPS monitoring scheme as described shall be provided in all new control panels:
- R. Managed Ethernet/Fiber Ring Switches
1. All Ethernet communications shall be routed to the Owner supplied network switch located in the network rack.
- S. Magnetic door contacts as security
1. Magnetic door contacts shall be monitored at the PLC. Install necessary voltage to integrate signal.
  2. The PLC shall provide output of door and hatch contacts to the door access system for security function.
  3. Provide a screen and allow alarm (selectable) for monitoring of the door and hatch magnetic contacts.

- T. Low Temperature Alarm Monitoring
  - 1. Furnish and install low temperature alarm thermostats with their output connections monitored at the PLC for various locations throughout the plant as indicated on the Drawings. Generate associated alarms and display on the computers.
- U. Floor Flood Alarm Monitoring
  - 1. Furnish and install flood alarm with their output connections monitored at the PLC for various locations throughout the plant as indicated on the Drawings. Generate associated alarms and display on the computers.

## 1.02 WELL PUMP

- A. The well pump control station has a HAND-OFF-AUTO selector switch.
  - 1. In HAND, the pump shall be called to run.
    - a. Pressure switch (PS-WP-19) shall provide proof of flow. VFD shall turn off well pump if pressure switch does not provide flow verification.
    - b. Pump speed shall be controlled from the VFD HIM.
  - 2. In OFF, the pump shall not be called to run.
  - 3. In AUTO, the pump shall be controlled by the PLC automatically based on levels in the Reservoir.
    - a. The well pump control station has a REMOTE-FLOATS selector switch.
      - 1) In REMOTE mode, Well Pump shall be controlled from the PLC and pressure transducer in the Reservoir.
        - (1) The PLC monitors the pressure transducer R-LT-1.
        - (2) Under normal operation, the pressure transducer is the active instrument that the PLC uses to control the pumps.
          - (a) Reservoir High level alarm setpoint. (operator adjustable in the SCADA OIT)
          - (b) Well Pump stop level (operator adjustable in the SCADA OIT)
          - (c) Well pump start level (operator adjustable in the SCADA OIT)
          - (d) Reservoir low level alarm setpoint (operator adjustable in the SCADA OIT)
      - b. In FLOATS mode, Well Pump shall be controlled off floats in the Reservoir and relays.
        - 1) Pump operation based on floats in the Reservoir
          - a) High Float, Well Pump Start, Low Float
          - b) If the water falls to the "Well Pump Start" LEH, will call the well pump to start.
          - c) If the water level rises to the high-level float LEHH, well pump shall turn off. Start a time delay countdown (operator adjustable) and if the float remains in high level condition after the countdown, send an alarm through SCADA.
          - d) If the water level falls to low level float LEL, Call the well pump to start. Send an alarm through SCADA.
    - 4. In Auto mode, the PLC shall control the speed of the VFD based on operator selection of two rate options. A digital selector switch shall be on the SCADA to select a pumping mode.
      - 1) Constant Speed Mode: the VFD shall run at a operator selected % full-speed set on the SCADA screen.
      - 2) Flow Rate Mode: the VFD shall adjust speed to match an operator set flow rate measured from the flowmeter FT-W-19.
- B. The well pump has a pre-lube solenoid that is controlled through the hardwired starter elementary circuits and is adjustable using a time delay relay.
  - 1. Pre-lube flow meter FE-WP-19-2 shall be used to verify proof of flow for the pre-lube system.
  - 2. If flow is not recorded after an operator adjustable time period, initially set to 10s, the Well Pump shall turn off and an alarm sent through SCADA.
- C. The well pump has motor thermal contacts, two (2) vibration sensors, and pressure proof-of-operation contacts that lockout the pump and those conditions are monitored as dry contacts to the PLC. Include programming to display and alarm these points.

### 1.03 BOOSTER PUMPS

- A. There are three booster pumps: BP-1, BP-2, and BP-3.
- B. Each booster pump local control station has a HAND-OFF-AUTO selector switch.
  - 1. In HAND, the pump shall be called to run.
  - 2. In OFF, the pump shall not be called to run.
  - 3. In AUTO, the pump speed shall be controlled by the PLC automatically based on three modes: Flow mode, pressure mode, and fire mode. A digital selector switch shall be on the SCADA to select a pumping mode.
    - a. Flow Mode:
      - 1) The SCADA system shall call for the booster pump to start by communicating to SCP-19 PLC.
    - b. Pressure Mode:
      - 1) Control from system discharge pressure transducer (PT-FW-2). Operator shall set the target discharge pressure on the OIT. The PLC shall control the VFD speed to maintain the discharge pressure.
      - 2) If a pump is at an operator adjustable low speed setpoint for an operator adjustable time period an alarm shall initiate in SCADA.
    - c. Fire Mode – Pumps 2 & 3 only:
      - 1) Operator selects fire mode on the OIT. The VFD speed is controlled to maintain an operator selected pressure on the discharge pressure transducer (PT-FW-2).
      - 2) Pumps shall not turn off based on low speed setpoint.
    - d. A START push button shall be available on the SCADA to start the lead booster pump. A STOP push button shall be available on the SCADA to stop the lead booster pump.
    - e. When the booster pump is called to run in AUTO mode, the PLC shall check the position of the reservoir fill valve BFV-RF-1. If the valve is 'open', the PLC shall call for the valve to close, and confirm the valve is in the closed position before calling the booster pump to start.
    - f. Pump Selection: The SCADA OIT screen shall have the ability to control the booster pump selection. The operator shall be able to select if a booster pump is part of the alternating sequence. If it is selected to be not in the alternating sequence, then the PLC shall not call for it so start. If it is selected to be in the alternating sequence, then the PLC shall alternate pumps each time a pump is called to start. Operator adjustable input shall be present in SCADA for number of time a pump serves as the lead pump before alternating
      - 1) In Pressure, if Pump No. 1 is running and cannot maintain target discharge pressure, after an operator adjustable period of time, PLC shall turn on next available pump and turn off pump No. 1.
      - 2) In Fire Mode, switch to Pump 2 or 3
      - 3) In Pressure and Fire Modes, if Pump No. 2 or Pump No. 3 are running and cannot maintain target discharge pressure, an alarm shall be send through SCADA.
  - 4. Interlocks and safeties:
    - a. If the water level falls to low level float LEL, lockout the booster pumps and send an alarm through SCADA. Pump shall remain locked out until the reservoir level rises to the activate the restore float.
    - b. Pump lockout based on reservoir hatch contacts: If a reservoir hatch contact is monitored to open, the PLC shall call for the booster pumps to stop running. An alarm shall be sent through SCADA.

### 1.04 RESERVOIR FILL VALVE

- A. BFV-RF-1 is a pneumatically actuated valve automatically controlled through the PLC.
- B. Valve is controlled manually with the operator calling for the valve to operate on the SCADA OIT. A software OPEN-AUTO-CLOSE selector switch will provide valve control using the OIT.
- C. Valve operation from closed position to open:
  - 1. Operator calls valve to open on the SCADA OIT. The PLC shall call the valve to open as long as the following conditions are not active.

- a. The PLC shall confirm that no booster pump is running before calling the valve to open. If a booster pump is running, send a alarm to the operator informing that the valve cannot be opened while a booster pump is running.
  - b. The PLC shall confirm that the reservoir high level float LEHH is not active before calling the valve to open. If a booster pump is running, send a alarm to the operator informing that the valve cannot be opened while a booster pump is running.
- D. Valve operation from open to closed position:
- 1. The operator calls valve to close on the SCADA OIT. PLC sends signal to close valve.
  - 2. The PLC monitors the reservoir transducer R-LT-1 and calls for the valve to close once an operator adjustable setpoint is reached.
- E. If the valve is open, and the reservoir high-high level float is tripped, the PLC shall automatically call the valve to close.

## 1.05 FILTER CONTROLS

- A. Filter Control Features: The filter controls in the SCADA system shall provide a semi-automatic mode for back washing. Each filter shall be equipped with a pneumatic open-close three way valve, see Section 44 44 73 (Pressure Filter System).
- 1. Filter standby mode:
    - a. Well #19 is not running.
    - b. Filter individual inlet 3-way pneumatic valves SV-F1 through SV-F16 are in the de-energized position.
    - c. The filter effluent valve FCV-FW-1 is open.
  - 2. Filtration Cycle:
    - a. Well #19 is running.
    - b. Filter individual inlet 3-way pneumatic valves SV-F1 through SV-F16 are in the de-energized position.
    - c. The filter effluent valve FCV-FW-1 is open. This valve shall be called to open at the same time that well #19 is called to run. This valve shall be called to close at the same time Well #19 stops running.
  - 3. Backwash Cycle:
    - a. A backwash cycle shall be initiated by the Plant Operator on the SCP-19 OIT touch panel. BACKWASH IN 'MANUAL MODE', AUTOMATIC MODE, AND SEMI-AUTOMATIC MODE.
    - b. IN AUTO MODE, the operator can select one of three modes of backwash initiation: Totalized flow since last backwash; differential pressure; runtime since last backwash. The operator shall be able to select which filter train(s) should be included in the backwash sequence (Train 1 (SV-F1 through SV-F8), Train 2 (SV-F9 through SV-F16), or both Trains 1 and 2).
    - c. Backwash tank selection
      - 1) There are two backwash tanks: Backwash Tank 1, Backwash Tank 2.
      - 2) The operator can select which backwash tanks should be in the automatic alternating sequence. If a backwash tank is removed from the alternating backwash sequence, it is assumed to be out of service.
      - 3) The PLC verifies that the backwash tank level for the tank next in the automatic sequence is at "ready for backwash" level. If it is not at "ready for backwash" level, then the PLC shall select the other tank if it is at ready for backwash level and proceed. If neither tank is at ready for backwash level, the SCADA OIT shall indicate alarm to the operator that neither backwash tank is at ready for backwash level.
    - d. The PLC shall initiate the backwash sequence by energizing the first filter valve in the train. At the same time the PLC shall open the associated backwash tank inlet valve (SV-BWT-1 or SV-BWT-2) and adjust the filter effluent valve FCV-FW-1 to maintain a flow through the backwash waste flowmeter FE-BWW-1 (initially set at 350 GPM).
    - e. The PLC shall start a filter cell backwash timer. The timer shall be adjustable on the SCADA OIT and initially set at 5-minutes.
    - f. After the filter backwash timer times out, energize the 2-way valve on the next filter cell in sequence to initiate backwash. After a set time delay, de-energize the 3-way valve on the preceding filter cell finishing backwash on that cell and putting it into service.

- g. Initiate the backwash timer again and repeat this sequence until all cells in the filter train selected for backwash have been backwashed.
- B. Interlocks and Safeties:
- 1. "Return to Service" push buttons simulated in the SCADA system computer shall abort a backwash cycle at any point during the cycle and return the cell to service.
- C. Alarms:
- 1. If terminal headloss is reached, an alarm shall be initiated and remain so until attention is provided by the plant operator. The Raw Water Valve shall close when terminal headloss in the filter is reached.
  - 2. If during a backwash cycle overflow water level in the backwash tank is reached, an alarm shall be initiated and the backwash sequence shall be stopped until attention is provided by the plant operator.
    - a. When alarm is initiated, filter valve of cell being backwashed shall de-energize.
    - b. Operators shall have the option to abort the backwash or resume backwash when acknowledging the alarm.
  - 3. If flow is not recorded in the backwash waste flowmeter after an operator adjustable time period, an alarm shall be initiated.
  - 4. Alarms shall be acknowledged via the SCADA system computer.

## 1.06 RECLAMATION CONTROL DESCRIPTION

- A. The reclamation system shall consist of two backwash tanks, two reclamation pumps, two sludge pumps, spraywash system, and associated control logic.
- 1. All operator adjustments and control features shall be readily accessible from the HMI system computers.
  - 2. Throughout the reclamation sequence, the related displays on the HMI system computers shall indicate real time status of the backwash tank and related equipment.
  - 3. Normal Cycle Description:
    - a. Normal cycle shall operate automatically.
    - b. After a filter have been backwashed into a given tank, an adjustable 0-24 hour settling timer shall be initiated.
    - c. Indicators in the HMI system computers shall "count down" the settling time remaining until the settling timer is timed out.
    - d. When the settling timer times out, the corresponding Reclaim Pump (BWR-1, BWR-2) shall start:
      - 1) There must be a minimum flow through the filters before a Reclaim Pump is allowed to run. An adjustable setting shall be obtained from the Raw Water Flow Meter (FT-WP-19-1). The operator shall have the option of a manually adjustable recycle flow rate or as a proportion of the raw water flow, maximum 10%.
      - 2) Temperature sensors supplied with the pump shall initiate a pump fail alarm and stop the pump upon an over temperature condition. Temperature monitoring units shall be furnished by the pump supplier for installation in the supervisory control panel.
      - 3) Seal chamber moisture sensors supplied with the pump shall initiate a pump fail alarm upon detection of moisture in the seal chamber. Moisture monitoring units shall be furnished by the pump supplier for installation in the supervisory control panel. A moisture alarm bypass switch shall be provided inside the control panel inner door to allow disconnecting the moisture alarm from the telemetry and the exterior alarm horn.
      - 4) Motor chamber moisture sensors (if supplied with the pump) shall initiate a pump fail alarm and stop the pump upon detection of moisture in the pump motor. Moisture monitoring units shall be furnished by the pump supplier for installation in the supervisory control panel.
    - e. When the water in the backwash tank lowers to an adjustable, pre-set level, the Reclaim Pump shall stop. After an operator adjustable number of backwashes, the corresponding sludge pump (BWS-1, BWS-2) shall start: BWS pumps have time restrictions for operation. In AUTO mode, it should only run between acceptable times set on the operator interface (initially set between 12am and 6am). The BWS is also limited on flow rate, initially set to 110gpm. The PLC shall control VFD speed to match the flow rate as set on the OIT.



- 1) Temperature sensors supplied with the pump shall initiate a pump fail alarm and stop the pump upon an over temperature condition. Temperature monitoring units shall be furnished by the pump supplier for installation in the supervisory control panel.
  - 2) Seal chamber moisture sensors supplied with the pump shall initiate a pump fail alarm upon detection of moisture in the seal chamber. Moisture monitoring units shall be furnished by the pump supplier for installation in the supervisory control panel. A moisture alarm bypass switch shall be provided inside the control panel inner door to allow disconnecting the moisture alarm from the telemetry and the exterior alarm horn.
  - 3) Motor chamber moisture sensors (if supplied with the pump) shall initiate a pump fail alarm and stop the pump upon detection of moisture in the pump motor. Moisture monitoring units shall be furnished by the pump supplier for installation in the supervisory control panel.
- f. When the water in the backwash tank lowers to the next adjustable, pre-set level, the spray wash system shall be activated by starting the adjustable, pre-set spray wash timer:
- 1) The timer shall open the corresponding Spray Wash Control Valve (BFV-SW-1, BFV-SW-2).
  - 2) The Sludge Pump shall continue running.
  - 3) The flow of spray wash water will be greater than the sludge pump rate.
  - 4) When the timer times out, the corresponding Spray Wash Control Valve shall close. The sludge pump shall continue pumping until the water level lowers to the next adjustable, pre-set level. An alarm shall be initiated if the spray wash valve does not close after a pre-selected time of 30 seconds.
- g. At this level, the Sludge Pump shall stop and the filter controls shall be permitted to refill the tank.
4. Special Reclamation Cycle Descriptions:
- a. The following devices shall be simulated in the HMI computers to allow the operator to alter the automatic reclamation sequence:
    - 1) "Manual Start - Automatic Run" push button for the Reclaim Pump (BWR-1, BWR-2) to allow the Reclaim Pump to be started before the corresponding backwash tank settling timer has timed out. The reclamation system shall then continue in the automatic mode to completion.
    - 2) "Manual Start - Automatic Run" push button to start the corresponding Sludge Pump to start, regardless of the status of the Reclaim Pump. The reclamation system shall then continue in the automatic mode to completion.
    - 3) "Cancel" push-button for each reclamation system to cancel or stop all operations within that system and reset the system to normal.
    - 4) "Re-Start" push-button for the backwash tank settling timer to re-start the settling timer in the reclamation system.
5. Alarms:
- a. If any valve or pump fails to operate an alarm shall be initiated.
  - b. Alarms shall be acknowledged via the alarm acknowledge pushbuttons on the 01-PLC or the HMI system computers.

## 1.07 FLOW METERS

- A. The following list of flow meters are specified in Section 43 22 52 - Magnetic Flow Meters. For each of these meters the SCADA system shall receive the 4-20mA output and discrete totalizer output (every 1000 gal) of the flow meter and indicate, totalize, record, and trend flows in the computer system.
- B. The Raw Water Flow Meter FT-WP-19-1 will measure the water from the well pump.
- C. Pre-lube Flow Meter FT-WP-19-2 will measure the water to the well pump pre-lube system.
- D. Backwash flowmeter FT-BWW-1 measures flow to the backwash tanks.
- E. Reclaim flowmeter FT-BWR-1 measures reclaim water from the backwash tank to the filters.
- F. Sludge pump flowmeter FT-BWS-1 measures flow from backwash sludge Pump 1 to waste.

- G. Sludge pump flowmeter FT-BWS-2 measures flow from backwash sludge Pump 2 to waste.
- H. Finished water flowmeter FE-FW-1 measures water to the ground storage reservoir.
- I. Finished water flowmeter FE-FW-2 measures water pumped by the booster pumps.

## 1.08 FLUORIDE SYSTEM

- A. The SCADA computers shall display all system information, allow manual control of each component, and allow adjustment of all parameters.
- B. The metering pump receptacle shall be energized when any well pump is running and the proof of flow pressure switch WP-19-PS-1 senses pressure. The metering pump speed shall be flow paced by a 4-20 mA signal proportional to the flow from the finished water flow meter.

## 1.09 CHLORINATION SYSTEM

- A. A flow proportioner shall be provided for the chlorination system to receive 4-20 mA flow signals from a flow measuring device. The flow proportioner shall adjust a motor-driven gas feed rate valve in response to changes in flow. The chlorination system shall receive a 4-20 mA signal from the PLC.
  - 1. After the startup of the well pump and flow verification from pressure switch WP-19-PS-1, feed rate shall be proportional to the raw water flow (combined raw water and recycle) for an operator adjustable time period (initially set to 10 minutes).
  - 2. After the operator adjustable time period is completed flow proportioner shall operate in a compound loop system in response to free chlorine residual levels measure measured by the chlorine residual analyzer (AIT-CL2-2)
- B. When the well pump starts the chlorination booster solenoid valve (normally closed) shall open. And the chlorination booster pump shall start. The booster pump shall provide the vacuum necessary for the chlorine ejector.
- C. A chlorine gas detector shall output a dry contact signal to the SCADA to initiate an alarm in the event of a chlorine release.
- D. Alarm beacon above the outside chlorine door shall energize on alarm event. Shall automatically turn off.
- E. Each of the cylinders shall be located on a scale. The scale indicator shall output 4-20 mA signal to the SCADA system proportional to the weight.

## 1.10 CHLORINE ANALYZERS

- A. Two (2) chlorine residual analyzers shall monitor residual chlorine
  - 1. AIT-CL2-2 shall monitor the pre-reservoir chlorine residual
    - a. AIT-CL2-2 shall be called to turn on and the solenoid valve SV-CL2-1 shall open when the well pump is in operation.
    - b. AIT-CL2-2 shall turn off and the solenoid valve SV-CL2-1 shall close when the well pump is offline.
  - 2. AIT-CL2-3 shall monitor the post-reservoir chlorine residual
    - a. AIT-CL2-3 shall be called to turn on and the solenoid valve SV-CL2-2 shall open when a booster pump is in operation.
    - b. AIT-CL2-3 shall turn off and the solenoid valve SV-CL2-2 shall close when all booster pumps are offline.
  - 3. The residual chlorine concentration for each analyzer shall be displayed on SCADA
  - 4. Alarms
    - a. An alarm shall be initiated in SCADA if the following are reached:
      - 1) An operator adjustable PRE-RESERVOIR HIGH CL alarm
      - 2) An operator adjustable PRE-RESERVOIR LOW CL alarm
      - 3) An operator adjustable POST-RESERVOIR HIGH CL alarm

- 4) An operator adjustable POST-RESERVOIR LOW CL alarm
- 5) All alarms shall be acknowledged by the SCADA computer

### **1.11 RESERVOIR MIXER**

- A. PLC to monitor running signal.

### **1.12 GRINDER PUMP**

- A. PLC to monitor high level alarm.
- B. PLC to monitor common alarm.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

Not Used

**END OF SECTION**

## SECTION 40 91 19

### INSTRUMENTATION

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Instrumentation:
  - 1. Switch - Float
  - 2. Switch - Limit (Position)
  - 3. Switch - Pressure
  - 4. Thermostat - Low Temperature Alarm
  - 5. Transducer - Submersible Level Tank
  - 6. Transducer - Submersible Well Level
  - 7. Transmitter - Pressure
  - 8. Alarm Beacon (outside chlorine room door)
  - 9. Vibration Monitor
- B. Testing and Commissioning
- C. Installation
- D. Instrumentation List

##### 1.02 RELATED SECTIONS

- A. 40 23 30 Process Piping Valves
- B. 43 22 52 Magnetic Flow Meters

##### 1.03 REFERENCES

- A. National Fire Protection Association (NFPA), latest adopted version.
- B. National Electrical Manufacturers Association (NEMA)
  - 1. NEMA ICS-2 Industrial Control Devices, Controllers, and Assemblies.
  - 2. NEMA 250 Enclosures for Electrical Equipment.
- C. Underwriters Laboratories (UL)
  - 1. UL 508 Industrial Control Equipment.
  - 2. UL 698A Industrial Control panels for Hazardous Locations.
  - 3. UL 913 Intrinsically-safe Apparatus and associated apparatus for use in Class I, II and III, Division 1, Hazardous Locations.

##### 1.04 GENERAL

- A. The work specified in this Section includes furnishing, installing, start-up, testing, and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.
- B. It shall be the responsibility of the Contractor to furnish a complete and fully operating system. The Contractor shall be responsible for all details which may be necessary to properly install, adjust and place in operation the complete installation. The contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Contract Documents.

- C. It shall be the responsibility of the Contractor and supplier to examine all new and existing equipment that is transmitting a signal to, or receiving a signal from, equipment specified in this Section. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in this Section and existing equipment or equipment specified in other Sections.
- D. The Contractor shall be responsible for selecting instrumentation models to have the proper range values for the system it is connected to and measuring.

## 1.05 SUBMITTALS

- A. Technical data in conformance with Division 1 and including:
  - 1. All equipment and components indicated on the Drawings and specified in Part 2 of this Section.
- B. Shop Drawings in conformance with Division 1 and including:
  - 1. Manufacturer's data or specification sheets for instrumentation and control devices showing design parameters, equipment catalog designations, calibration range, and clearly identifying options provided.
  - 2. Certified outline drawings
  - 3. Installation drawings including mounting and grounding requirements.
  - 4. Wiring connection drawings for equipment and accessories provided. Wiring interconnection drawings shall define terminal numbers and functions for interface with other instruments and equipment.
- C. Operational and Maintenance data in conformance with Division 1 and including:
  - 1. Field devices and instruments, including "as-build" system schematics.
  - 2. Provide hard copies as required in Division 1.
- D. Start-up report from system supplier per requirements of Division 1.
- E. Spare Equipment Lists- Provide a list of recommended spare parts and equipment that is considered spare parts and equipment that is considered crucial to the operation of the system. Include list of parts for each item.

## PART 2 PRODUCTS

### 2.01 FLOWMETER - MAGNETIC

- A. See specification 43 22 52.

### 2.02 SWITCH - FLOAT

- A. Floor "Flood" Monitoring:
  - 1. Float switch with Buna-N float and 316 stainless steel stem; 1 1/2 inch.
  - 2. Wall-mounted bracket.
  - 3. Single-pole, single-throw, magnetically-actuated switch.
  - 4. Manufacturer/Model for non-chemical rooms:
    - a. GEMS LS-270, or equivalent.
- B. Water Application:
  - 1. Polypropylene with encapsulated non-mercury type switch.
  - 2. Contact rating - 3 Amps at 120 VAC, resistive.
  - 3. Operating differential - 1 inch, nominal.
  - 4. Extra-flexible cord in length suitable for the application.
  - 5. Manufacturer: US Filter, Flygt, Anchor Scientific, or equal.

### 2.03 SWITCH - LIMIT (POSITION)

- A. Unit shall be of corrosion resistant construction plus factory pre-wired and sealed.
- B. Operation shall occur via compatible corrosion resistant lever arm rotation by either clockwise or counterclockwise direction.
- C. Factory provided "pigtail" cord shall be Type ST00W-A.
- D. Acceptable Manufacturers
  - 1. Allen Bradley 802MC series with 802MC-W series lever arms.
  - 2. Approved equivalent.

### 2.04 SWITCH - MAGNETIC PROXIMITY (DOOR CONTACT)

- A. Hermetically sealed.
- B. Magnetic door position switch.
- C. Wide gap model.
- D. Manufacturer: Sentrol 2500 Series or equivalent.

### 2.05 SWITCH - PRESSURE

- A. Pressure switch assemblies suitable for both liquids and gasses.
- B. Provide pressure switches with calibrated setpoint mechanisms.
- C. Pressure sensing element: diaphragm or bellows.
- D. Nema 4X epoxy coated aluminum, 300 series stainless steel, or baked enamel coated steel.
- E. 316 stainless steel block and bleed valves (1-inch for diaphragm seal installations) screw and ball type suitable for operating pressures up to 400psi at 200 degrees F or 150pse saturated steam.
- F. Seats and stem seals to be constructed of Teflon and provide bubble tight shutoff.
- G. Ball and stem materials to be same as pressure element.
- H. Manufacturers: Allen-Bradley, Ashcroft, Square D, or equivalent.

### 2.06 THERMOSTAT - ALARM

- A. Harsh or corrosive environment:
  - 1. Devices:
    - a. TS-1.
  - 2. Corrosion resistant enclosure with external bulb and SPDT contacts.
  - 3. 40–100 degrees F adjustable range with calibrate scale in increments of 2 degrees F.
  - 4. Chromalox #WCRT-100, Honeywell T631A, or equal.
- B. Chemical rooms:
  - 1. Devices:
    - a. TS-CL-1.
  - 2. Remote Bulb thermostat.
  - 3. 5ft stainless steel capillary tube.
  - 4. 0-100 deg F adjustable range with calibrate scale in increments of 1 degree F.
  - 5. Honeywell T675-A or equal.

## 2.07 TRANSDUCER – SUBMERSIBLE LEVEL TANK

- A. Submersible unit that measures hydrostatic head of liquid, using variable-capacitance or variable-resistance transducer.
- B. Corrosion-resistant stainless steel and PVC construction.
- C. 2" minimum diameter sensing surface with flexible membrane for wastewater/sludge applications. Provide 1-inch maximum unit diameter and sensing surface for clean water and monitoring well application.
- D. Two-wire, loop-powered integral transmitter that receives operating power from a 4-20 mAdc loop. And controls the loop current in proportion to level over the specified range.
- E. Provide stainless steel hardware and lifting cable to allow removing unit without entering wetwell.
- F. Manufacture:
  - 1. Esterline "KPSI" Series 750.
  - 2. Or approved equal.

## 2.08 TRANSDUCER - SUBMERSIBLE WELL LEVEL

- A. Submersible unit that measures hydrostatic head of liquid, using variable-capacitance or variable-resistance transducer.
- B. Corrosion-resistant stainless steel and PVC construction.
- C. Maximum 3/4-inch diameter for installation in well tube. Cable length as required for well depth to connection to terminations.
- D. Two-wire, loop-powered integral transmitter that receives operating power from a 4-20 mAdc loop. And controls the loop current in proportion to level over the specified range.
- E. Manufacture:
  - 1. Esterline "KPSI" Series 300.
  - 2. Or approved equal.

## 2.09 TRANSMITTER - PRESSURE (ELECTRONIC)

- A. Electronic indicating-type pressure transmitters shall convert a gauge or absolute pressure measurement to a 4-20 mAdc linear electrical output signal capable of transmission into at least a 600-ohm maximum load at 24 Vdc or less. Transmitter shall include Hart protocol signal over 4-20 mA output. Signal and power transmission shall be provided on a single pair of wires. Operating ambient temperature limits shall be at least -40°C to +82°C.
- B. Range shall be as indicated in Instrument Schedule. Over range protection shall be at least 1-1/2 times span without degradation of accuracy. Reference accuracy shall be  $\pm 1/2$  percent or better.
- C. Provide gauge or differential pressure transmitter as required.
- D. Transmitter enclosure shall be mounted remotely from the pressure tap location as shown on the drawings.
- E. Transmitter is to include digital display for local reading.
- F. Provide a block and bleed valve for pressure transmitters.
- G. Supplied with isolation diaphragm and filled with liquid to separate from process liquid.

- H. Manufacturer:
  - 1. Foxboro IGP055-T22D1FN-L1 (Schneider Electric).

## **2.10 VALVE - ELECTRICALLY OPERATED SOLENOID**

- A. NEMA 4X enclosure under normal conditions.
- B. 32-deg F to 125-deg F.
- C. UL Listed.
- D. 120-Volt AC or 24-Volt DC as required by controls system.
- E. Brass or 304 Stainless steel body construction.
- F. NBR or PTEE Seals and Discs.
- G. 304 stainless steel core tube and springs.
- H. ASCO Red Hat II, or equivalent.

## **2.11 ALARM BEACON**

- A. Multi-mode (flashing or steady on).
- B. LED light source with more than 100,000 hours median life.
- C. Mounting option based on location (bracket, pendant, or ceiling). Use Bracket mount for location above exterior chlorine room door.
- D. US listed for Class 1, Division 2.
- E. Red lens.
- F. 120-VAC.
- G. Edwards Signal 107XBRBMR120A, or equivalent.

## **2.12 VIBRATION MONITOR FOR MOTOR**

- A. Analog output 4-20mA proportional to vibration.
- B. CTC model CTC LP202-6R1-1E.
- C. Provide Two units for the well pump.

## **PART 3 EXECUTION**

### **3.01 LABELING**

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number and item description.
- B. Labels shall be engraved laminated plastic with 1/4-inch high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.



### **3.02 CALIBRATION, ADJUSTING AND TESTING**

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.
- B. Install and set up wireless access ports, access ports shall be laid out to cover the Influent Waste complex only.

### **3.03 INSTALLATION AND START-UP**

- A. Control devices shall be provided and wired as shown on the Drawings. Control schematics and wiring connections shown on the Drawings are based upon the equipment specified and the typical wiring diagrams furnished by the manufacturer. The Contractor shall review the wiring diagrams for the equipment actually furnished and modify the wiring shown on the Drawings to conform to the requirements of the equipment furnished. The Contractor will not be compensated for extra labor and materials which are required to change wiring which was not confirmed with the equipment manufacturer's drawings.
- B. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions are required for start-up.

### **3.04 ACCEPTANCE TESTING**

- A. After the installation is complete, and proper operation has been demonstrated, a 60-day acceptance test shall begin. The entire system shall be required to operate for 60 days with no malfunctions, field repairable malfunctions excepted. Any malfunction during the 60-day test which cannot be corrected within 24 hours by the supplier shall be considered a non-field repairable malfunction and after repairs are complete, the test shall be repeated.
- B. The acceptance test shall apply to all equipment furnished under this Section.

**END OF SECTION**

## SECTION 40 92 13

### CONTROL PANELS AND SCADA SYSTEM COMPONENTS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Control Panels
- B. Local Control Stations
- C. Installation, Identification, Testing and Commissioning, and Training.

##### 1.02 RELATED SECTIONS

- A. Section 40 23 20 - Process Piping Valves
- B. Section 40 90 00 - Control System Functional Descriptions
- C. Section 40 90 05 - Commissioning
- D. Section 40 91 19 - Instrumentation
- E. Section 40 92 40 Process Valve Actuators

##### 1.03 REFERENCES

- A. National Fire Protection Association (NFPA), latest adopted version.
- B. National Electrical Manufacturers Association (NEMA)
  - 1. NEMA ICS-2 Industrial Control Devices, Controllers, and Assemblies.
  - 2. NEMA 250 Enclosures for Electrical Equipment.
- C. Underwriters Laboratories (UL)
  - 1. UL 508 Industrial Control Equipment.
  - 2. UL 698A Industrial Control panels for Hazardous Locations.
  - 3. UL 913 Intrinsically safe Apparatus and associated apparatus for use in Class I, II and III, Division 1, Hazardous Locations.

##### 1.04 SCOPE

- A. Furnish and install a new control system for the Deep Well #19 facility as described herein. This shall include but not be limited to:
  - 1. New Main Control Panel SCP-19 at the well facility.
    - a. Controls Systems Integrator shall design and provide all aspects of the PLC control panel as specified herein, except that the City of Madison will provide the Hope Industrial Computer/OIT, The Dell Optiplex computer to the Controls Systems Integrator for installation and integration with the PLC control panel.
  - 2. New Remote Control Panel RCP-19 at the well facility.
    - a. Controls Systems Integrator shall design and provide all aspects of the control panel as specified herein, except that the City of Madison will provide the Hope Industrial Computer/OIT and the Dell Optiplex computer to the Controls Systems Integrator for installation and integration with the PLC control panel.
  - 3. Motor Control Center as specified in Section 26 24 19.

- B. Software Licenses and Programming
  - 1. The City of Madison will provide all PLC, computer, OIT, HMI software licenses and programming as part of this project. Programming will follow the functional descriptions outlined in Section 40 90 00.
  - 2. Controls System Integrator shall closely coordinate with the City's programmer to make sure that the PLC control panel design coordinates with the programming and operating requirements.
- C. It is the intent of the Contract Documents that all equipment specified in this Section of the specifications be supplied by a single-source supplier ("Systems Integrator"). The supplier shall assume full responsibility along with the Contractor for furnishing, installing and start-up procedures so as to make the system operate per the intent of the Contract Documents.
- D. The work specified in this Section includes furnishing, installing, start-up, testing, and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.
- E. It shall be the responsibility of the Contractor to furnish a complete and fully operating system. The Contractor shall be responsible for all details which may be necessary to properly install, adjust and place in operation the complete installation. The contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Contract Documents.
- F. It shall be the responsibility of the Contractor and supplier to examine all new and existing equipment that is transmitting a signal to, or receiving a signal from, equipment specified in this Section. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in this Section and existing equipment or equipment specified in other Sections.
- G. It is the intent of the Contract Documents that a complete plant control system be provided and installed to include but not limited to PLCs, programming, instruments, controls, and ancillary devices for a complete and operational system.
- H. The labor specified herein includes but is not limited to engineering software development, panel fabrication, equipment calibration and adjustment, testing, training, and documentation.
- I. This section includes coordination with the work of other sections and requires identification of exact interface requirements with motor and control devices provided under other portions of this specification. It shall be the responsibility of the Systems Integrator specified under this section to execute this coordination during the shop drawing submittal phase of the work.
- J. This section includes coordination with electrical contractor to ensure that the proper number and type of conductors are installed. It shall be the responsibility of the Systems Integrator to coordinate this work with the installing electrician.

## 1.05 SUBMITTALS

- A. Technical data in conformance with Division 1 and including:
  - 1. All equipment and components indicated on the Drawings and specified in Part 2 of this Section.
  - 2. Software packages including complete description of features and capabilities.
- B. Shop Drawings in conformance with Division 1 and including:
  - 1. Panel Drawings including system schematic drawings, terminal numbering, wire numbering, component schematic drawings, dimension drawings, layout drawings and nameplate schedule.
    - a. Panel exterior general arrangement drawings showing location of surface and flushed mounted equipment.
    - b. Panel interior arrangement drawings including:
      - 1) Locations and identification of terminal blocks.
      - 2) Locations and identification of racks/chassis and equipment mounted within.

- 3) Arrangement of other equipment mounted inside panel identified by instrument tag number.
    - c. Exterior panel wiring interface termination diagrams.
  - 2. Provide complete new drawings for all existing panels that are modified under this Contract. Re-draw existing circuitry based on record drawings furnished by Owner. Drawings shall include all existing components and circuitry, and shall include all proposed components and circuitry.
  - 3. Overall system diagram showing all components, converters, cables, and connectors.
  - 4. Proposed computer and operator interface unit graphic displays. Submit "rough" or hand-drawn copies prior to programming.
  - 5. Proposed report formats written specific to the project.
- C. Operational and Maintenance data in conformance with Division 1 and including:
  - 1. Panel equipment, field devices and instruments, including "as-build" system schematics.
  - 2. Removeable media containing final PLC program, final operator interface application files and final distributed control software application fillies.
  - 3. Removeable media containing final system record drawings, wiring diagrams and panel details. The drawings files shall be in AutoCAD format (.DWG files).
  - 4. Complete software documentation including programming information and operator's guides. Include hard copies of all operator interface unit and computer graphic screens.
- D. Start-up report from system supplier per requirements of Division 1.
- E. Spare Equipment Lists- Provide a list of recommended spare parts and equipment that is considered spare parts and equipment that is considered crucial to the operation of the system.
- F. All submittals shall be bound in 3-ring binders with labeled tabs separating sections.

#### **1.06 TESTING AGENCY CERTIFICATION**

- A. All new panels and subpanels furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment", and applicable portions of UL Standards 698A - "Industrial Control Panels for Hazardous Locations" and UL Standard 913 - "Intrinsically-Safe Apparatus and Associated Apparatus for use in Class I, II and III, Division 1, Hazardous Locations".

#### **1.07 QUALITY ASSURANCE**

- A. All materials, equipment, and parts shall be new and unused of current manufacture.
- B. System Integrator shall be responsible for providing all necessary accessories required for a complete and operational system.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicted.

#### **1.08 SOFTWARE - GENERAL**

- A. Any software purchased shall be licensed directly to the Owner who will maintain final ownership and control. Provide proof of licensing to the Owner and any passwords or codes to the Owner. Include this information with the O&M Submittals. Note that the Owner will provide the licenses for the PLC program, the HMI program, and the Dell Optiplex and Hope Industrial computer software.

#### **1.09 FUNCTIONAL DESCRIPTIONS**

- A. See Section 40 90 00.

## PART 2 PRODUCTS

### 2.01 INTEGRATOR

- A. Systems integrator shall be one of the following:
1. L.W. Allen, Madison, WI, Mark Kane, (608) 222-8622.
  2. Integrated Process Solutions, Inc., Waunakee, WI, Eric Fisher, 608-849-4375
  3. No substitutions.

### 2.02 SCP-19 CONTROL PANEL FABRICATION – GENERAL

- A. Enclosures for indoor control panels shall meet the following minimum requirements:
1. NEMA 12 unless otherwise specified.
  2. Fabricate control panel of 12-gage carbon steel plate with all-welded construction throughout. Welds shall be ground smooth, corners shall be rounded, and weld spatter cleaned. Corner construction shall be minimum of 1/8 inch inside radius.
  3. 90 inches high, 20 inches deep, multiples of 36 inches wide, unless shown otherwise.
  4. Surface of control panel shall be free from mars and defects. Finished panel surfaces shall be flat within 1/16 inch in 6'-0" and be smooth with rounded edges. Finished panel surfaces shall be 3/16-inch (5 mm) thick. Instrument cutouts and drilling shall be straight and true.
  5. Provide 10-gage full height access doors. Access doors shall have triple-point latch, stainless steel handle and lock, full-length stainless steel "piano" type hinge, and sponge rubber gaskets. Door shall be supplied with devices to hold door in 105° position when fully opened.
  6. Provide, full-width, full height, real rectangular subpanel for surface mounting of programmable controller, other surface-mounted instruments, wiring troughs, and terminals strips.
  7. Provide full-length, side-mounted subpanels for installation of terminal strips.
  8. Base of control panel shall be adequately reinforced to permit anchoring to concrete pad.
  9. Supply 4 identical master keys which will operate all locks of control panel.
  10. All inside and exterior surfaces treated to prevent oxidation and painted. White on interior, manufacturer's standard color on exterior.
  11. Devices mounted on control panel door.
    - a. Hope industrial touchpanel.
    - b. PLC SCAN FAIL red pilot light.
    - c. Chlorine room horn silence Pushbutton.
    - d. RJ-45 jack.
    - e. Programming power outlet.
    - f. Reservoir Control Selector Switch (REMOTE-OFF(RESET)/BACKUP FLOATS)
      - 1) This needs to be clarified through control loops.
- B. 12-inch by 12-inch by 1-inch pocket for drawing storage on inside face of panel or inside exterior door.
- C. Provide each panel/enclosure with industrial corrosion inhibitor emitters of sufficient size and quantity to protect contents of enclosure size selected. Emitters shall contain additional red metal inhibitors to protect brass and copper material in addition to ferrous metals. Hoffman A-HC110E or equal.
- D. All components labeled per shop drawings.
1. Engraved labels attached with screws.
- E. All wiring terminated on barrier-type terminal strips. Terminal strips shall be labeled with engraved plastic labels.
1. Labels shall be attached with two-part epoxy adhesive.
  2. 600-volt terminal strips.
  3. Ring or spade type clamp connectors.
  4. Wiring laced using plastic ties and plastic wiring troughs.
  5. Wiring held down with straps attached to enclosure with screws.
  6. Separate power, control and signal conductors.
  7. Power wiring: #14 AWG, stranded, 600V copper minimum.
  8. Control wiring: #18 AWG, stranded, 600V copper minimum.

9. Signal wiring: shielded, 300V copper minimum. See Division 26.
  10. Provide 15-amp, 10,000 AIC breaker on power circuits using #14 wire.
  11. Connections to instruments via terminal strip or connectors. Soldering wired to terminal strips in not acceptable.
- F. Tag all wires at each end with wire number matching shop drawings.
- G. Programmable Logic Controller (PLC)
1. Programmable logic controller capable of performing relay logic, timing, counting, sequencing, mathematical, proportional-integral-derivative (PID) control, and other functions as required by the functional descriptions in this section. Provide complete unit with rack, power supply, modules, cables, and connectors.
  2. Auto start-up after power failure. Retain program and setpoints so that system starts automatically when power is restored.
  3. Provide live digital and analog inputs/outputs as indicated on Drawings, plus live spares and extra slots as specified in Part 1 of this Section. Minimum total inputs/outputs capability shall be 480 points per PLC.
  4. Provide 20 percent additional I/O point for each type of I/O (DI, DO, AI, AO). Spare I/O shall be wired to terminal block inside panel.
  5. I/O Requirements
    - a. Digital inputs
      - 1) Optically isolated input rated to withstand up to 1500 VAC transients.
      - 2) Voltage as indicated,  $\pm 10$  percent.
      - 3) Maximum of sixteen (16) inputs points per common neutral.
      - 4) LED indicator.
    - b. Digital outputs
      - 1) Voltage as indicated.
      - 2) Capable of continuously driving up to 0.5-amp load.
      - 3) LED indicator.
    - c. Analog inputs
      - 1) Field selectable 4-20mA<sub>dc</sub> or 1-5 VDC input on each channel.
      - 2) Input isolation rated 500 volts minimum.
      - 3) 16-bit analog-to-digital conversion having overall accuracy of  $\pm 0.75$  percent of full scale or better.
      - 4) 250-ohm input impedance (on 4-20 mA input).
      - 5) 1 Megohm input impedance (on 1-5 VDC input).
    - d. Analog outputs
      - 1) 0 to 20mA<sub>dc</sub> range. Nominal span of 4-20mA<sub>dc</sub>.
      - 2) Digital-to-analog conversion having overall accuracy of  $\pm 0.75$  percent of full scale or better.
      - 3) Capable of driving up to 750ohm load.
  6. Programmable in ladder logic using IBM-compatible computer as described in the functional description in this Section. Provide programming software that is standard product of the PLC manufacture. Software shall allow on-line program editing without interrupting PLC operation. Software shall have an advanced instruction set including timing, sequencing, relay logic, close-loop PID control, mathematical, trigonometric, Boolean, floating-point and integer calculations, and time and event-based interrupts.
  7. PLCs shall have Ethernet ports and RS-232 serial ports to allow communications between systems components, all as described in the functional descriptions in this Section. Provide all required interface modules and converters.
  8. Environmental
    - a. Operating temperature - 0° to 50°C.
    - b. Humidity – 0 to 95 percent (non-condensing).
    - c. Noise immunity – comply with NEMA ICS-2-230.
  9. Manufacturer
    - a. Allen-Bradley “CompactLogix” Model 5069-L320ER processor with associated I/O cards, including options specified, and manufacturer’s programming software.
    - b. No Substitutions.

- H. Operator Interface Terminal
  - 1. Hope Industrial Touchpanel Computer will be provided by the City for installation on the control panel door. Integrator to show on all design drawings and install and wire.
- I. Industrial Computer
  - 1. Dell Optiplex industrial computer will be provided by the City for installation inside the control panel. Integrator to show on all design drawings and install and wire.
- J. Industrial Ethernet Switch
  - 1. All Ethernet communications from the PLC Control Panel shall be routed to the wall-mount data rack. This includes the PLC, Dell Optiplex, Hope Industrial Computer.
- K. Surge protection
  - 1. 120VAC, 15 Amp rated in-line device. Listed for protection from ANSI/IEEE CG62.41 Category A and B Transients.
  - 2. 300 V peak Clamping voltage.
- L. Terminals
  - 1. NEMA - style, barrier type, 0.4-inch spacing, nominal.
  - 2. 600V RMS, 55-amp rating.
  - 3. UL listed.
  - 4. Allen-Bradley 1492-CA1 series, or equal.
  - 5. Terminals for larger power circuits shall be 600 VAC barrier-type, sized for the conductors.
- M. Surge suppressor terminal blocks.
  - 1. Provide surge suppressor terminal blocks for analog and discrete signals that leave building structure:
    - a. Analog signal blocks: Voltage rating 24-volt ac/dc; Phoenix Contact TT-SLKK5-S-24DC, Allen Bradley 1492-HM2K024 Series, or equal.
    - b. Discrete signal blocks: Voltage rating 120-volt ac/dc; Phoenix Contact TT-SLKK5/110AC, Allen Bradley 1492-HM2K120 Series, or equal.
- N. Direct current power supply
  - 1. Series pass semiconductor type, adjustable with  $\pm 1.0$  percent regulation, no load to full load from all causes, total.
  - 2. Operating source: 120 VAC, 60 Hz.
  - 3. Output protection: current limiting and "crowbar" circuit. Fused not permitted.
  - 4. At initial operation power supply loading shall not exceed 50 percent of rating under any condition.
  - 5. Convection cooled.
  - 6. All power supplies on the project shall be identical.
- O. Uninterruptible Power Supply (UPS) – in control panels
  - 1. 120 VAC, 60 Hz single-phase input and output.
  - 2. Size at 150 percent of connected panel load or 700 VA capacity (continuous), whichever is larger, with 5-minute battery reserve time (at full-load).
  - 3. Continuous on-line, double-conversion type that continuously rectifies, stores, recreates the 120 VAC sinusoidal output waveform for the load. Include features that allow operation in critical environments and high-harmonic and/or noisy applications. Include adjustable input voltage parameters so that the input stage will accept low-quality input power.
  - 4. Eaton Powerware Series Model 9130 or approved equal.
- P. Circuit Breakers:
  - 1. Circuit breakers will be UL labeled and shall be of the size shown. Provide breakers with an interrupting rating of not less than 22,000 amperes, symmetrical.
  - 2. Circuit breakers that are downstream of a main breaker or control panel step-down transformer may have 10,000 amperes interrupting rating.

- Q. Control Switches
  - 1. Electronic Circuits
    - a. Selector, momentary pushbutton or momentary selector as required. Positions as required for application.
    - b. Heavy duty, oil-tight, contacts as required.
    - c. Gold flashed contacts; initial resistance, 0.01 ohms; 0.5 amps at 120 VAC, resistive.
  - 2. Control Circuits
    - a. Selector, momentary pushbutton, or momentary selector as required. Positions as required for application.
    - b. Heavy duty, oil-tight, contacts as required.
    - c. Contact rating shall conform to NEMA A-600.
  - 3. Pushbutton Color
    - a. Red: Stop.
    - b. Green: Run.
    - c. White: Power on.
  
- R. Control Relays and Timing Relays
  - 1. Plug-in type with dust cover, socket and locking spring when relay mounted horizontally.
  - 2. Coil: continuous operation at 120 VAC  $\pm$ 10 percent unless shown otherwise.
  - 3. Contacts, 3 pole, double throw, minimum.
    - a. 10 amps, make-break, 120 VAC, resistive.
    - b. Insulation resistance: 1000 megohms at 500 VDC.
    - c. Dielectric: 2000 VAC, 60 Hz.
  - 4. Operating time
    - a. 35 milliseconds (nominal) energization.
    - b. 100 milliseconds (nominal) de-energization.
  - 5. Mechanical life: 106 operations.
  - 6. Temperature: 0 to 70 degrees C.
  - 7. Timing relays shall be of the same manufacturer and series as control relays. Provide electronic timers with range as indicated.
  
- S. Indicating Lights.
  - 1. Sunlight visible, 30.5mm, high visibility LED.
  - 2. "Push-to-Test" type.
  - 3. Heavy-duty, oil-tight.
  - 4. NEMA 4 rating.
  - 5. Allen Bradley 800T, or equal.
  - 6. Colors.
    - a. Required: Amber.
    - b. Running: Green.
    - c. Off: Red.
    - d. Power on: White.
    - e. Alarm: Red.
  
- T. Other devices as necessary for a complete control panel installation.
  
- U. Corrosion inhibitors: Hoffman A-HC110E or equal.

### **2.03 RCP-19 CONTROL PANEL FABRICATION - GENERAL**

- A. Enclosures for indoor control panels shall meet the following minimum requirements:
  - 1. NEMA 12 unless otherwise specified.
  - 2. Fabricate control panel of 12-gage carbon steel plate with all-welded construction throughout. Welds shall be ground smooth, corners shall be rounded, and weld spatter cleaned. Corner construction shall be minimum of 1/8 inch inside radius.
  - 3. Wall-mount 36 inches high, 18 inches deep, 36 inches wide, as minimum size. Provide larger size if required to meet panel layout requirements.



4. Surface of control panel shall be free from mars and defects. Finished panel surfaces shall be flat within 1/16 inch in 6'-0" and be smooth with rounded edges. Finished panel surfaces shall be 3/16-inch (5 mm) thick. Instrument cutouts and drilling shall be straight and true.
  5. Provide 10-gage full height access doors. Access doors shall have triple-point latch, stainless steel handle and lock, full-length stainless steel "piano" type hinge, and sponge rubber gaskets. Door shall be supplied with devices to hold door in 105° position when fully opened.
  6. Provide, full-width, full height, real rectangular subpanel for surface mounting of controllers, other surface-mounted instruments, wiring troughs, and terminals strips.
  7. Provide full-length, side-mounted subpanels for installation of terminal strips.
  8. Base of control panel shall be adequately reinforced to permit anchoring to concrete pad.
  9. Wall-mount anchors.
  10. All inside and exterior surfaces treated to prevent oxidation and painted. White on interior, manufacturer's standard color on exterior.
  11. Devices mounted on control panel door.
    - a. Hope industrial touchpanel.
    - b. RJ-45 jack.
- B. 12-inch by 12-inch by 1-inch pocket for drawing storage on inside face of panel or inside exterior door.
- C. Provide each panel/enclosure with industrial corrosion inhibitor emitters of sufficient size and quantity to protect contents of enclosure size selected. Emitters shall contain additional red metal inhibitors to protect brass and copper material in addition to ferrous metals. Hoffman A-HC110E or equal.
- D. All components labeled per shop drawings.
1. Engraved labels attached with screws.
- E. All wiring terminated on barrier-type terminal strips. Terminal strips shall be labeled with engraved plastic labels.
1. Labels shall be attached with two-part epoxy adhesive.
  2. 600-volt terminal strips.
  3. Ring or spade type clamp connectors.
  4. Wiring laced using plastic ties and plastic wiring troughs.
  5. Wiring held down with straps attached to enclosure with screws.
  6. Separate power, control and signal conductors.
  7. Power wiring: #14 AWG, stranded, 600V copper minimum.
  8. Control wiring: #18 AWG, stranded, 600V copper minimum.
  9. Signal wiring: shielded, 300V copper minimum. See Division 26.
  10. Provide 15-amp, 10,000 AIC breaker on power circuits using #14 wire.
  11. Connections to instruments via terminal strip or connectors. Soldering wired to terminal strips in not acceptable.
- F. Tag all wires at each end with wire number matching shop drawings.
- G. Operator Interface Terminal
1. Hope Industrial Touchpanel Computer will be provided by the City for installation on the control panel door. Integrator to show on all design drawings and install and wire.
- H. Industrial Computer
1. Dell Optiplex industrial computer will be provided by the City for installation inside the control panel. Integrator to show on all design drawings and install and wire.
- I. Industrial Ethernet Switch
1. All Ethernet communications from the PLC Control Panel shall be routed to the wall-mount data rack. This includes the Dell Optiplex, Hope Industrial Computer.
- J. Surge protection
1. 120VAC, 15 Amp rated in-line device. Listed for protection from ANSI/IEEE CG62.41 Category A and B Transients.
  2. 300 V peak Clamping voltage.

- K. Terminals
  1. NEMA – style, barrier type, 0.4-inch spacing, nominal.
  2. 600V RMS, 55-amp rating.
  3. UL listed.
  4. Allen-Bradley 1492-CA1 series, or equal.
  5. Terminals for larger power circuits shall be 600 VAC barrier-type, sized for the conductors.
  
- L. Surge suppressor terminal blocks.
  1. Provide surge suppressor terminal blocks for analog and discrete signals that leave building structure:
    - a. Analog signal blocks: Voltage rating 24-volt ac/dc; Phoenix Contact TT-SLKK5-S-24DC, Allen Bradley 1492-HM2K024 Series, or equal.
    - b. Discrete signal blocks: Voltage rating 120-volt ac/dc; Phoenix Contact TT-SLKK5/110AC, Allen Bradley 1492-HM2K120 Series, or equal.
  
- M. Uninterruptible Power Supply (UPS) – in control panels
  1. 120 VAC, 60 Hz single-phase input and output.
  2. Size at 150 percent of connected panel load or 500 VA capacity (continuous), whichever is larger, with 5-minute battery reserve time (at full-load).
  3. Continuous on-line, double-conversion type that continuously rectifies, stores, recreates the 120 VAC sinusoidal output waveform for the load. Include features that allow operation in critical environments and high-harmonic and/or noisy applications. Include adjustable input voltage parameters so that the input stage will accept low-quality input power.
  4. APC SmartUPS, or approved equal.
  
- N. Circuit Breakers:
  1. Circuit breakers will be UL labeled and shall be of the size shown. Provide breakers with an interrupting rating of not less than 22,000 amperes, symmetrical.
  2. Circuit breakers that are downstream of a main breaker or control panel step-down transformer may have 10,000 amperes interrupting rating.
  
- O. Other devices as necessary for a complete control panel installation.
  
- P. Corrosion inhibitors: Hoffman A-HC110E or equal.

## **2.04 LOCAL CONTROL STATIONS (SHOWN AS “LCS” ON DRAWINGS)**

- A. Provide local control stations to house selector switches, pushbuttons, and pilot lights at the equipment location to meet the configurations shown on the drawings.
  1. Outdoor control stations shall be NEMA 4X, 316 stainless steel construction. Allen-Bradley 800T or equivalent.
  2. Indoor control stations shall be NEMA 4X, Gray thermoplastic polyester blend. Allen-Bradley 800H or equivalent.
  3. Local control station pilot devices shall be per the requirements of the drawings. If no requirements are shown, provide a three-position selector switch (Hand-Off-Auto), a red alarm pilot light, and a green running pilot light.

## **2.05 TERMINATION ENCLOSURES**

- A. Enclosures shall meet the following minimum requirements:
  1. NEMA 4X, Type 316 stainless steel.
  2. Removable steel inner panel, painted white.
  3. Minimum 24 inches high, 8 inches deep, 16 inches wide. Actual size shall be by the Systems Integrator.
  4. Panels shall be flanged, corners welded ground smooth.
  5. Stainless steel continuous hinge.
  6. Clamp type with padlocking.
  7. Manufacture by Hoffman, or equal.

- B. All wiring terminated on barrier-type terminal strips. Terminal strips shall be labeled with engraved plastic labels.
  - 1. Labels shall be attached with two-part epoxy adhesive.
  - 2. 600-volt terminal strips.
  - 3. Ring or spade type clamp connectors.
  - 4. Wiring laced using plastic ties and plastic wiring troughs.
  - 5. Wiring held down with straps attached to enclosure with screws.

## **PART 3 EXECUTION**

### **3.01 LABELING**

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number and item description.
- B. Labels shall be engraved laminated plastic with ¼" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.

### **3.02 CALIBRATION, ADJUSTING AND TESTING**

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.

### **3.03 PROJECT MANAGEMENT**

- A. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this specification.
- B. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.

### **3.04 PROGRAMMING SERVICES**

- A. Program the programmable logic controllers (PLCs) and computer as required by the functional descriptions.
- B. Provide additional programming during start-up, training, and call-back periods as specified.

### **3.05 INSTALLATION AND START-UP**

- A. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- B. Conduct a two-day demonstration of all system features and functions to Owner and Engineer.
- C. Coordinate installation and start-up scheduling with Owner and Engineer.

### **3.06 ACCEPTANCE TESTING**

- A. On-Site Testing and Commissioning:
  - 1. Provide services of a systems integrator technician checkout, test, and commission the system on Project Site.
  - 2. Place equipment into service and provide operation as specified.

3. Provide actual activation of each control function and alarm in the system. If actual activation is not possible, the function shall be simulated. The Owner or Engineer shall witness and sign off on each function.
  4. Record all Changes in the Control Systems:
    - a. Revise all wiring diagrams and schematic diagrams to show final installation.
    - b. Insert revised diagrams into each operation and maintenance manual in place of original diagrams.
- B. After the installation is complete, and proper operation has been demonstrated, a 60-day acceptance test shall begin. The entire system shall be required to operate for 60 days with no malfunctions, field repairable malfunctions excepted. Any malfunction during the 60-day test which cannot be corrected within 24 hours by the supplier shall be considered a non-field repairable malfunction and after repairs are complete, the test shall be repeated.
- C. The acceptance test shall apply to all equipment furnished under this Section.

### **3.07 ON-SITE SERVICES**

- A. In addition to other services specified, provide a competent programmer/instrumentation engineer or technician to perform the following services:
1. Software revisions - Five (5), eight (8) hour days on-site to make software revisions per Owner and Engineer direction. Days shall be no-continuous, number trips five (5).
  2. Training - One (1) eight (8) hour days on-site to train Owner's personnel on:
    - a. Operation and maintenance of all equipment furnished.
    - b. Computer software operation and programming including building reports, building graphics and modifying tags and database.
- B. All on-site services shall be at times approved by Owner.
- C. At project completion, supplier shall certify in Writing that all un-used service hours will be provided at Owner's request during the first three years of operation. The remaining service hours shall be fulfilled by either a software engineer or field service technician as required by the task required by the Owner, at no cost.

### **3.08 CALL-BACK SERVICES**

- A. In addition to other services specified, provide a competent programmer/instrumentation engineer or technician to return to the project site for two (2), non-consecutive eight (8) hour days during the first year of operations. During each trip, the supplier's representative shall be prepared to calibrate and check equipment furnished under this contract, give miscellaneous training, and make software revisions.
- B. Call-back trips shall be at times determined by the Owner.

### **3.09 SUPPLIES**

- A. Contractor shall provide all expandable items such as lamps, fuses, etc. For system startup, checkout, and during the acceptance test.

### **3.10 SPARE PARTS**

- A. Contractor shall furnish the following spare parts to the Owner. Spares shall be delivered in boxes labeled on the outside with manufacturer and part number identified on the box:
1. Two (2) DC power supplies (as used in control panels)
  2. Six (6) each of every type of control relay used in control panels.
  3. Twenty (20) percent spare fuses and lamps of each type furnished, but not less than six (6) of each type.

### 3.11 MAINTAINING AUTOMATIC CONTROLS DURING CONSTRUCTION

- A. Contractor shall coordinate construction activities to keep the existing plant instrumentation and controls system operational throughout the course of the project. Contractor shall furnish and install temporary controls and wiring as required to maintain automatic operation, and shall remove such temporary controls and wiring once permanent controls and wiring are operational and accepted.
- B. When existing panel or instruments are modified or replaced under this Contract, Contractor shall schedule the work in advance with Owner and Engineer, and shall perform the Work so as to minimize the impact on Owner's operation of the facility. Controls shall only be removed from automatic operation during normal working hours, Monday thru Friday.
- C. For scheduled outages or cutovers, once the control system revisions begin, Contractor shall work continuously until automatic operation is restored.

### 3.12 PLC INPUT AND OUTPUT LIST

- A. **The estimated input/output list is provided below.** This list shall not be considered all-inclusive and Contractor shall estimate input/output requirements based on all information provided in each specification section and the drawings. This list is prepared to give an estimation of the inputs and outputs that are required, but it is up to the Contractor to provide a complete control system that is inclusive of all the control system requirements described in this, and other specification sections and shown on the drawings to function as required.

SCP-19 SUPERVISORY CONTROL PANEL		
DEVICE	DESCRIPTION	I/O TYPE
LE-R-H	FLOAT SWITCH HIGH	DI
LE-R-L	FLOAT SWITCH LOW	DI
LE-R-LL	FLOAT SWITCH LOW-LOW	DI
R-LT-1	LEVEL TRANSMITTER	AI
GP-LT-1	LEVEL TRANSMITTER	AI
WP-19-LT-1	LEVEL TRANSMITTER	AI
BW-LT-1	LEVEL TRANSMITTER	AI
BW-LT-2	LEVEL TRANSMITTER	AI
LE-BW1-H	FLOAT SWITCH HIGH	DI
LE-BW1-L	FLOAT SWITCH LOW	DI
LE-BW1-LL	FLOAT SWITCH LOW-LOW	DI
LE-BW2-H	FLOAT SWITCH HIGH	DI
LE-BW2-L	FLOAT SWITCH LOW	DI
LE-BW2-LL	FLOAT SWITCH LOW-LOW	DI
FT-FW-1	FLOW METER SIGNAL	AI
FT-FW-2	FLOW METER SIGNAL	AI
FT-WP-19-1	FLOW METER SIGNAL	AI
FT-BWR-1	FLOW METER SIGNAL	AI
FT-BWW-1	FLOW METER SIGNAL	AI
FT-SW-1	FLOW METER SIGNAL	AI
FT-SW-2	FLOW METER SIGNAL	AI
MP-FL-1 START	START CHEM METER PUMP RECEPTACLE	DO
MP-FL-1 AO	CHEM FEED PACING SIGNAL	AO
HZ-CL2	GAS SHUT-OFF ACTIVATED	DI
GF1-CL2	GAS FEEDER RATE SIGNAL	AO
GF1-CL2	GAS FEEDER RUN	DO
GF1-CL2	GAS FEEDER FAIL	DI
SV-CL2-1	SOLENOID VALVE SIGNAL	DO
AIT-CL2-1 DETECTOR	GAS LEAK DETECTOR LEVEL	AI
AIT-CL2-1 ALARM	GAS LEAK DETECTOR ALARM	DI
AIT-CL2-1 TROUBLE	GAS LEAK DETECTOR TROUBLE	DI

AIT-CL2-2	CHLORINE ANALYZER	AI
AIT-CL2-3	CHLORINE ANALYZER	AI
WIT-FL-1	SCALE	AI
WIT-CL2-1	SCALE CYLINDER 1	AI
WIT-CL2-1	SCALE CYLINDER 2	AI
KEYSCAN	DOOR ACCESS CONTROLLER ALARM	DI
FD-1	FLOOD ALARM SWITCH	DI
DC-1	DOOR CONTACT OPEN	DI
DC-2	DOOR CONTACT OPEN	DI
DC-3	DOOR CONTACT OPEN	DI
DC-4	DOOR CONTACT OPEN	DI
DC-5	DOOR CONTACT OPEN	DI
DC-6	DOOR CONTACT OPEN	DI
DC-7	DOOR CONTACT OPEN	DI
DC-8	DOOR CONTACT OPEN	DI
DC-9	DOOR CONTACT OPEN	DI
DC-10	DOOR CONTACT OPEN	DI
DC-11	DOOR CONTACT OPEN	DI
DC-12	DOOR CONTACT OPEN	DI
DC-13	DOOR CONTACT OPEN	DI
DC-14	DOOR CONTACT OPEN	DI
DC-1	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-2	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-3	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-4	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-5	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-6	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-7	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-8	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-9	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-10	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-11	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-12	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-13	DOOR CONTACT OPEN TO KEYSCAN	DO
DC-14	DOOR CONTACT OPEN TO KEYSCAN	DO
TS-1	LOW TEMPERATURE ALARM THERMOSTAT	DI
TS-2	LOW TEMPERATURE ALARM THERMOSTAT	DI
TS-3	LOW TEMPERATURE ALARM THERMOSTAT	DI
TS-4	LOW TEMPERATURE ALARM THERMOSTAT	DI
TS-5	LOW TEMPERATURE ALARM THERMOSTAT	DI
SV-F1	SOLENOID VALVE SIGNAL	DO
SV-F2	SOLENOID VALVE SIGNAL	DO
SV-F3	SOLENOID VALVE SIGNAL	DO
SV-F4	SOLENOID VALVE SIGNAL	DO
SV-F5	SOLENOID VALVE SIGNAL	DO
SV-F6	SOLENOID VALVE SIGNAL	DO
SV-F7	SOLENOID VALVE SIGNAL	DO
SV-F8	SOLENOID VALVE SIGNAL	DO
SV-F9	SOLENOID VALVE SIGNAL	DO
SV-F10	SOLENOID VALVE SIGNAL	DO
SV-F11	SOLENOID VALVE SIGNAL	DO
SV-F12	SOLENOID VALVE SIGNAL	DO
SV-F13	SOLENOID VALVE SIGNAL	DO
SV-F14	SOLENOID VALVE SIGNAL	DO
SV-F15	SOLENOID VALVE SIGNAL	DO
SV-F16	SOLENOID VALVE SIGNAL	DO

SV-BWW-1	SOLENOID VALVE SIGNAL	DO
LSO-SV-BWW-1	VALVE LIMIT SWITCH OPEN	DI
LSC-SV-BWW-1	VALVE LIMIT SWITCH CLOSE	DI
SV-BWW-2	SOLENOID VALVE SIGNAL	DO
LSO-SV-BWW-2	VALVE LIMIT SWITCH OPEN	DI
LSC-SV-BWW-2	VALVE LIMIT SWITCH CLOSE	DI
SV-SW-1	SOLENOID VALVE SIGNAL	DO
LSO-SV-SW-1	VALVE LIMIT SWITCH OPEN	DI
LSC-SV-SW-1	VALVE LIMIT SWITCH CLOSE	DI
SV-SW-2	SOLENOID VALVE SIGNAL	DO
LSO-SV-SW-2	VALVE LIMIT SWITCH OPEN	DI
LSC-SV-SW-2	VALVE LIMIT SWITCH CLOSE	DI
PT-DP-1	FILTER DIFFERENTIAL PRESSURE TRANSDUCER	AI
PT-DP-2	FILTER DIFFERENTIAL PRESSURE TRANSDUCER	AI
SV-BFV-RF-1	SOLENOID VALVE SIGNAL	DO
LSO-BFV-RF-1	VALVE LIMIT SWITCH OPEN	DI
LSC-BFV-RF-1	VALVE LIMIT SWITCH CLOSE	DI
FCV-FW-1 AO	MOTORIZED VALVE POSITION SIGNAL	AO
FCV-FW-1 AI	MOTORIZED VALVE POSITION SIGNAL	AI
PT-WP-19-1	PRESSURE TRANSDUCER	AI
PT-FW-1	PRESSURE TRANSDUCER	AI
PT-FW-2	PRESSURE TRANSDUCER	AI
CP-GPS	GRINDER PUMPS COMMON ALARM	DI
MCC-PM	MCC MOUNTED POWER METER MONITORED OVER ETHERNET. MONITOR: VOLTAGE THREE PHASES, AMPERAGE THREE PHASES, kW, kVA	ETHERNET
VFD-WP-19 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-WP-19 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-WP-19 RUNNING	PUMP RUNNING CONTACT	DI
VFD-WP-19 FAIL	PUMP FAIL CONTACT	DI
VFD-WP-19 START	PUMP CALL TO RUN SIGNAL	DO
VFD-WP-19 OVERTEMP	PUMP OVERTEMP RELAY	DI
VFD-WP-19 VIBRATION N/S	HIGH VIBRATION TRANSDUCER NORTH/SOUTH DIRECTION	AI
VFD-WP-19 VIBRATION E/W	HIGH VIBRATION TRANSDUCER EAST/WEST DIRECTION	AI
VFD-WP-19 VIBRATION	PLC VIBRATION LOCKOUT RELAY	DO
VFD-BP-1 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-BP-1 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-BP-1 RUNNING	PUMP RUNNING CONTACT	DI
VFD-BP-1 FAIL	PUMP FAIL CONTACT	DI
VFD-BP-1 START	PUMP CALL TO RUN SIGNAL	DO
VFD-BP-1 OVERTEMP	PUMP OVERTEMP RELAY	DI
VFD-BP-1-LSO	VALVE LIMIT SWITCH OPEN	DI
LS-BP VIA TD3	VALVE FAIL TO OPEN LIMIT SWITCH LOCKOUT	DI
VFD-BP-2 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-BP-2 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-BP-2 RUNNING	PUMP RUNNING CONTACT	DI
VFD-BP-2 FAIL	PUMP FAIL CONTACT	DI
VFD-BP-2 START	PUMP CALL TO RUN SIGNAL	DO
VFD-BP-2 OVERTEMP	PUMP OVERTEMP RELAY	DI
VFD-BP-2-LSO	VALVE LIMIT SWITCH OPEN	DI
LS-BP-2 VIA TD3	VALVE FAIL TO OPEN LIMIT SWITCH LOCKOUT	DI
VFD-BP-3 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-BP-3 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-BP-3 RUNNING	PUMP RUNNING CONTACT	DI
VFD-BP-3 FAIL	PUMP FAIL CONTACT	DI

VFD-BP-3 START	PUMP CALL TO RUN SIGNAL	DO
VFD-BP-3 OVERTEMP	PUMP OVERTEMP RELAY	DI
VFD-BP-3-LSO	VALVE LIMIT SWITCH OPEN	DI
LS-BP-3 VIA TD3	VALVE FAIL TO OPEN LIMIT SWITCH LOCKOUT	DI
VFD-BWW-1 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-BWW-1 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-BWW-1 RUNNING	PUMP RUNNING CONTACT	DI
VFD-BWW-1 FAIL	PUMP FAIL CONTACT	DI
VFD-BWW-1 START	PUMP CALL TO RUN SIGNAL	DO
VFD-BWW-1 LLCO	BACKWASH TANK LOW LEVEL CUT OUT	DO
VFD-BWW-1 LLCO	LOW LEVEL CUTOUT RELAY	DI
VFD-BWW-1 OVERTEMP	PUMP OVERTEMP RELAY	DI
VFD-BWW-2 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-BWW-2 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-BWW-2 RUNNING	PUMP RUNNING CONTACT	DI
VFD-BWW-2 FAIL	PUMP FAIL CONTACT	DI
VFD-BWW-2 START	PUMP CALL TO RUN SIGNAL	DO
VFD-BWW-2 LLCO	BACKWASH TANK LOW LEVEL CUT OUT	DO
VFD-BWW-2 LLCO	LOW LEVEL CUTOUT RELAY	DI
VFD-BWW-2 OVERTEMP	PUMP OVERTEMP RELAY	DI
VFD-BWR-1 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-BWR-1 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-BWR-1 RUNNING	PUMP RUNNING CONTACT	DI
VFD-BWR-1 FAIL	PUMP FAIL CONTACT	DI
VFD-BWR-1 START	PUMP CALL TO RUN SIGNAL	DO
VFD-BWR-1 LLCO	BACKWASH TANK LOW LEVEL CUT OUT	DO
VFD-BWR-1 LLCO	LOW LEVEL CUTOUT RELAY	DI
VFD-BWR-1 OVERTEMP	PUMP OVERTEMP RELAY	DI
VFD-BWR-2 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
VFD-BWR-2 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
VFD-BWR-2 RUNNING	PUMP RUNNING CONTACT	DI
VFD-BWR-2 FAIL	PUMP FAIL CONTACT	DI
VFD-BWR-2 START	PUMP CALL TO RUN SIGNAL	DO
VFD-BWR-2 LLCO	BACKWASH TANK LOW LEVEL CUT OUT	DO
VFD-BWR-2 LLCO	LOW LEVEL CUTOUT RELAY	DI
VFD-BWR-2 OVERTEMP	PUMP OVERTEMP RELAY	DI
STR-BP-CL2 IN HAND	PUMP HOA SWITCH IN HAND POSITION	DI
STR-BP-CL2 IN AUTO	PUMP HOA SWITCH IN AUTO POSITION	DI
STR-BP-CL2 RUNNING	PUMP RUNNING CONTACT	DI
STR-BP-CL2 START	PUMP CALL TO RUN SIGNAL	DO
FACP ALARM	FIRE ALARM CONTROL PANEL ALARM	DI
FACP TROUBLE	FIRE ALARM CONTROL PANEL TROUBLE	DI

**END OF SECTION**



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## SECTION 40 92 40

### PROCESS VALVE ACTUATORS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Pneumatic power-actuating devices for process valves.
- B. Related Sections:
  - 1. Section 09 91 50 - Shop Painting
  - 2. Section 40 23 04 - Process Piping Valves and Operators

##### 1.02 REFERENCES

- A. AWWA:
  - 1. C540 - Power-Actuating Devices for Valves and Sluice Gates
  - 2. C541-08 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
- B. Materials:
  - 1. Alloy cast iron: ASTM A436.
  - 2. Aluminum: ASTM B179, Alloy 356.1.
  - 3. Aluminum: ASTM B85.
  - 4. Brass or Bronze: ASTM B154, less than 7 percent zinc.
  - 5. Cast iron: ASTM A126.
  - 6. Cast steel: ASTM A216.
  - 7. Carbon steel: ASTM A108.
  - 8. Ductile iron: ASTM A536.
  - 9. Electroless-nickel plate: ASTM B733.
  - 10. Fabricated steel: ASTM A36, ASTM A516.
  - 11. Nickel-copper alloy: ASTM B127, ASTM B164.
  - 12. Stainless steel: ASTM Z276, type 304 or better.
  - 13. Zinc alloy: ASTM B-240.

##### 1.03 DESIGN REQUIREMENTS

- A. Features:
  - 1. The following shall be completed without removal of the actuator covers:
    - a. Setting of the torque levels and position limits.
    - b. Configuration of the indication contacts.
- B. Sizing:
  - 1. Size actuator to ensure valve closure at the differential pressure at each location.
  - 2. Verify differential pressures at each location prior to ordering.
  - 3. Coordinate with valve manufacturer to ensure proper sizing for each valve model and size.
- C. Commissioning Tools:
  - 1. Provide with each actuator.
  - 2. Shall not form an integral part of the actuator.
  - 3. Shall meet enclosure protection and certification levels of the actuator.
  - 4. Shall be removable for secure storage/authorized release.
  - 5. Ensure protection of configured actuator settings by a means independent of access to the commissioning tool.

## 1.04 PERFORMANCE REQUIREMENTS

- A. Environmental:
  - 1. Suitable for indoor and outdoor use.
  - 2. Capable of functioning in an ambient temperature range of 32 degrees F to 100 degrees F.
  - 3. Capable of functioning in relative humidity up to 100 percent.
- B. Operating Speed:
  - 1. Provide valve opening and close at 12 inches per minute.
  - 2. Capable of adjustment.
- C. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10 percent below normal.

## 1.05 SUBMITTALS

- A. Product Data: Submit Product Data for each type of actuator provided.
- B. Shop Drawings: Submit scaled Shop Drawings for each size and type of actuator provided.
- C. Quality Assurance:
  - 1. A list of actuators to be provided for each application which includes:
    - a. Torque capabilities.
    - b. Operating torques.
      - 1) Seating.
      - 2) Unseating.
  - 2. Certificates of performance testing.
- D. Close-out:
  - 1. System start-up reports.
  - 2. Operation and maintenance manuals.

## PART 2 PRODUCTS

### 2.01 CYLINDER-TYPE PNEUMATIC ACTUATORS

- A. Supply cylinder-type pneumatic actuators capable of open/close operation and/or modulating operation where specified or indicated in the Drawings. Provide actuators for valves as indicated on the Valve Schedule in the Drawings on Sheet GP4.
- B. Where specified or indicated in the Drawings, valves are to be supplied with enclosed pneumatic cylinder operators and shall have a disc maximum stop limit and position indicator.
- C. Shaft seals and seats shall be suitable for continuous operation up to 180 degrees F.
- D. Cylinder shall be double-acting with stop nuts provided to position cylinder. The air compressor for operation of the pneumatic system shall be provided as specified in Section 22 15 00.
- E. Pneumatic cylinder operators shall be rigid-mounted without swivel movement during valve operation. A manual operator shall also be provided, which is able to function in the event of loss of air pressure in the pneumatic operators.
- F. Conform to the requirements of AWWA C540 and C541.
- G. Materials
  - 1. Cylinder Head and End Caps: Ductile iron.
  - 2. Piston Rod: chrome plated stainless steel.

3. Epoxy coat interior surfaces.
- H. Valve supplier shall determine torque requirement of butterfly valve for selection of actuator based on a flow rate of 400 gpm.
- I. Air Supply:
  1. Normal operation: 80 psi air supply.
  2. Pressure rating: 150 psi.
- J. Solenoid Valves:
  1. 4-way solenoid valves for 120V, 60 Hz, single-phase, AC power supply shall be furnished for each operator.
  2. Solenoid valves shall be NEMA 4X and shall be mounted on the operator or in a solenoid cabinet.
  3. Rate of opening and closing adjustment shall be provided for all solenoid valves.
- K. Limit Switches:
  1. All pneumatic actuators shall be furnished with limit switches as follows:
    - a. Mechanical function, quick set cam actuated limit switches.
    - b. Two (2) SPDT contacts rated 10A continuous at 120VAC.
    - c. NEMA 4X enclosure, epoxy coated, cast aluminum, explosion proof, watertight, corrosion proof enclosure.
    - d. One 3/4-inch and one 1/2-inch conduit entries.
    - e. Indicator Lights
      - 1) Red: valve closed.
      - 2) Green: valve open.
    - f. Limit switches shall be by the same manufacturer as the actuators.
- L. Fail Positions:
  1. Valves shall fail to either a fully open or fully closed position in the case of air pressure loss.
  2. Loss of power shall cause valve to return to normal open/close fail position.
  3. See Valve Schedule for the fail position of each valve.

## 2.02 MANUFACTURERS

- A. The pneumatic actuators shall match the valve manufacturers and be of the following:
  1. Henry Pratt Company: Pratt MDT actuator and Dura-Cyl® cylinder.
  2. DeZurik approved equal.

## 2.03 ACCESSORIES

- A. Supply each actuator with a start-up kit.
  1. Content:
    - a. Installation manual.
    - b. Electrical wiring diagram.
    - c. Cover seals to make good any site losses during the commissioning period.
    - d. Supply sufficient tools to enable set up and adjustment during valve/ actuator installation, testing, and commissioning.
- B. Furnish and install an air line moisture, dirt and oil extractor unit at process air supply source (Coordinate with Section 22 15 00)

## 2.04 FABRICATION

- A. Cylinder actuators for valves 3-inch through 8-inch shall be of the scotch yoke type. Valve sizes 10-inch and larger shall be supplied with a compound link and lever arrangement designed to minimize water hammer by providing characterized opening and closing. The concept of characterized closure is to reduce the flow area quickly to 20 percent open in the first half of the actuator stroke, and then slow down the disc travel to close off the last 20 percent of the flow area.

- B. All wetted parts of the cylinder shall be nonmetallic, except the cylinder rod which shall be chromium plated stainless steel. The rod seals shall be of the nonadjustable, wear compensating type. A rod wiper for removing deposits inside the cylinder shall be provided in addition to an external dirt wiper. Cylinder actuator can be supplied with an optional manual override.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install equipment and accessories in accordance with manufacturer's instructions.

### **3.02 FIELD QUALITY CONTROL**

- A. The manufacturer or duly appointed representative shall provide the following services:
  - 1. After installation and prior to start-up:
    - a. Inspect all installations.
    - b. Perform necessary adjustments and modifications.
  - 2. During start-up operations: Supervise initial start-up.
  - 3. Post start-up:
    - a. Make all final adjustments.
    - b. Provide minimum of 8 hours of operation and maintenance training for Owner's personnel.

**END OF SECTION**

## SECTION 40 95 26

### PROCESS INSTRUMENTATION PIPING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Process instrumentation piping and fitting materials for pneumatically controlled valves, pneumatic filter control panels, and air diaphragm pumps.
- B. Related Sections:
  - 1. Section 40 23 00 - Process Piping General Provisions
  - 2. Section 40 23 04 - Process Piping Valves and Operators
  - 3. Section 40 23 30 - Process Piping Specialties
  - 4. Section 40 23 40 - Process Piping Hangers and Supports

#### PART 2 PRODUCTS

##### 2.01 PIPES AND FITTINGS

- A. Instrumentation Air Piping:
  - 1. Inside Above Floor:
    - a. Type L, hard drawn seamless copper tubing.
    - b. Wrought copper solder fittings.
    - c. Join using 95-5 solder.
    - d. Short connections to fixtures and equipment: Type K, soft drawn copper tubing.
  - 2. Underground Piping:
    - a. Type K, soft drawn copper tubing.
    - b. No joints permitted.

##### 2.02 UNIONS

- A. For Copper Tubing:
  - 1. Soldered ground joint union.
  - 2. Chase 402, or equal.

##### 2.03 VALVES

- A. Acceptable Manufacturers:
  - 1. Apollo
  - 2. Nibco-Scott
  - 3. Milwaukee
  - 4. Watts
  - 5. Hammond
  - 6. Crane
  - 7. Stockham
  - 8. Powell
  - 9. Jenkins
  - 10. Lunkenheimer
  - 11. DeZurik
  - 12. Grinnell
  - 13. Demco

- B. For Service Pipe:
  - 1. Solder End Ball Valve:
    - a. 300 psi WOG.
    - b. Bronze, 2-piece body.
    - c. Stainless steel ball.
    - d. Extended stem to allow for insulation.
    - e. Lever handle.
    - f. Teflon seats and seal.
    - g. Nibco S580, Apollo 70-200 Series, or equal.
  - 2. Check Valve:
    - a. Screwed lift check.
    - b. 300 psi WOG.
    - c. Bronze body and trim.
    - d. 300-degree F composition disc.
    - e. Stockham B322, Crane 27, or equal.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Provide support system for piping in accordance with Section 40 23 40.
- B. Connections to Miscellaneous Equipment:
  - 1. Install connections to equipment, piping, and valves on service mains or branches.
  - 2. Allow for variations in connections and locations as required for each piece of equipment.

### **3.02 FIELD QUALITY CONTROL**

- A. Pressure Test: Perform pressure test on instrumentation air piping prior to insulating or concealing and connecting to equipment.
- B. Perform air test on piping:
  - 1. Pressure: 50 psig.
  - 2. Duration: 24 hours.
  - 3. Allowable Pressure Drop: None.

**END OF SECTION**

## SECTION 43 21 13

### HORIZONTAL CENTRIFUGAL SPLIT CASE PUMPS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes the furnishing and installation of horizontal split case centrifugal pumps, motor, mounting bases, anchor bolts, and appurtenances necessary for satisfactory operation.
- B. Pump shall be installed in lay length provided location of the existing booster pumps.
- C. Related Sections:
  - 1. Section 09 91 50 - Shop Painting
  - 2. Section 26 29 24 - Variable Frequency Drives

##### 1.02 PERFORMANCE REQUIREMENTS

- A. Liquid Temperature Range: 40-70 degrees F.
- B. Meet or exceed the operating condition requirements listed at the end of this section.
- C. NSF 61/372 compliant.
- D. Performance Requirements.
  - 1. Design basis Small Booster Pump (QTY1):
    - a. Fairbanks Morse 1824 single-stage, split-case, horizontal centrifugal pump.
    - b. Impeller: 444A329.
    - c. Suction: 6-inch.
    - d. Discharge: 5-inch.
    - e. Speed: 1800 rpm.
  - 2. Design Condition:
    - a. Full speed (1775 rpm).
    - b. Provide 1,400 gpm against a total dynamic head of 175 feet.
    - c. Minimum efficiency at this speed = 77 percent.
    - d. Minimum shut-off head: 210 feet.
    - e. Runout flow: 1,950 gpm at 120 feet.
  - 3. Design Basis Large Booster Pumps (Qty 2)
    - a. Fairbanks Nijhuis 1823 single-stage, split case, horizontal centrifugal pump.
    - b. Impeller: 444R330.
    - c. Suction: 8-inch.
    - d. Discharge: 6-inch.
    - e. Speed: 1800 rpm.
  - 4. Design Condition:
    - a. Full speed on (1775 rpm).
    - b. Provide 2,100 gpm against a total dynamic head of 175 feet.
    - c. Minimum efficiency at this speed = 81 percent.
    - d. Minimum shut-off head: 215 feet.
    - e. Runout flow: 2900 gpm at 105 feet.

##### 1.03 SUBMITTALS

- A. Product Data:
  - 1. Preliminary characteristic performance curves.
  - 2. List of pump components and materials.



- B. Shop Drawings:
  1. Pump schematic.
  2. Component sizes and dimensions.
  3. Field measurements of existing piping conditions including available space between pipe flanges to remain.
- C. Test Reports: Certified factory H.I. performance test results for pumps to be provided prior to shipping.
- D. Manufacturer's Operation and Maintenance Instructions.
- E. Close-out:
  1. Performance test results from installed units.
  2. Provide within 7 days of field testing.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Fairbanks Morse, Kansas City, KS
- B. Approved equal.

**2.02 EQUIPMENT**

- A. High Service Pump Schedule
  1. High Service Pump No. 1: HSP-1.
  2. High Service Pump No. 2: HSP-2.
  3. High Service Pump No. 3: HSP-3.
- B. General Requirements:
  1. Split case centrifugal pump with shaft in the horizontal orientation.
  2. Quantity: three (3).
  3. NSF 61 and NSF 372 Listed to comply with the Reduction of Lead in Drinking Water Act.
  4. Maximum Speed: 1800 rpm.
  5. Rated Motor Horsepower: (QTY 1) Small Booster:100 HP; (QTY 2) Large Boosters: 125 HP.
  6. Power Supply: 480V, 3-phase, 60 Hz.
  7. Acceptable Pumps:
    - a. Fairbanks Morse Pump
      - 1) Size: 5-inch 1824 (QTY 1); and 6-inch 1823 (QTY 2).
      - 2) Maximum pressure: 250 psig.
    - b. Other pumps are acceptable only if they meet all the requirements of this specification and with prior approval by Engineer.
- C. Materials
  1. Casing: Cast iron (ASTM A48.)
  2. Impeller (for use with chlorinated water above 2 PPM): Alpha Nickel Aluminum Bronze or 316 Stainless Steel.
  3. Shaft Sleeve: 316 stainless steel.
  4. Shaft: Steel AISI C1045.
  5. Casing Wear Ring: 416 stainless steel.
  6. Impeller Wear Ring: 316 stainless steel.
  7. Base Plate: Structural steel or cast iron.
- D. All pumps furnished under this section shall be provided by the same manufacturer.

**2.03 COMPONENTS**

- A. Casing:
  1. Horizontal split cast design.

2. Flange Connections: ANSI 125 pound rated.
  3. Tapped and plugged holes for priming and draining.
  4. Provide for removal of the rotating element without disconnecting the suction or discharge piping.
  5. Furnish lower half of casting with cored passageways from the high-pressure area of the volute to each seal box for positive lubrication without the use of external flushing lines.
  6. Integrally cast bearing arms with lower half of casing to ensure positive bearing alignment.
  7. Bolt-on bearing arms are not acceptable.
- B. Impeller:
1. Enclosed type, vacuum cast in one piece.
  2. Dynamically balanced.
  3. Key to shaft.
  4. Exterior Finish: Turned.
  5. Interior Finish: Finished smooth, free of burrs, trimmings, and irregularities.
- C. Shaft Sleeves:
1. Seal sleeve to impeller hub by means of an O-ring.
  2. Positively drive sleeve to the keyway.
  3. Fasten the sleeve to the shaft by means that the manufacturer recommends.
- D. Shaft Seal: Mechanical, Type 21.
- E. Shaft:
1. One piece, finished and polished on all sections.
  2. Length: Shortest practicable distance between bearings to minimize deflection and vibration.
  3. Maximum Allowable Deflection: 0.002 inches at any point on the pump operating curve.
- F. Casing Wearing Ring:
1. Radial type.
  2. Press fit into casing.
- G. Bearings:
1. Regreasable lubrication ball type.
  2. Average Life: 100,000 hours.
  3. Radial Loads: Provide single row inboard bearings.
  4. Thrust Loads: Provide double row outboard bearings.
  5. Mount bearings in moisture and dust proof machined housing.
  6. Housing:
    - a. Registered fits to ensure alignment.
    - b. Pinned, to prevent rotation.
    - c. Bolt to bearing arms.
  7. Supply each housing with grease fitting and plugged relief port.
- H. Coupling:
1. Provide flexible coupling to connect pump and motor shaft.
  2. All metal type with flexible rubber insert.
  3. Enclose entire rotating coupling element by means of a coupling guard.
- I. Base Plate:
1. Mount pump and motor on:
    - a. Groutable steel base plate.
    - b. Steel drip rim base plate.
  2. Incorporate integral drip channels on each side.
  3. Provide NPT connection and plug for each channel.
  4. Capable of supporting pump and motor without the use of additional supports or members.
- J. Nameplate:
1. Mount permanent nameplate in a prominent location on the pump.

2. Include the following information:
  - a. Manufacturer's name.
  - b. Serial number.
  - c. Pump design characteristics.

K. Motors:

1. NEMA configuration.
2. Premium efficiency.
3. Totally enclosed, fan-cooled.
4. Design for normal starting torque and low starting current.
5. Size: Sufficient to operate pump from shutoff head to open discharge without operating in the motor service factor.
6. Horsepower Rating: Sufficient to operate pump at any point on the head-capacity curve without overloading the nameplate horsepower rating of the motor, regardless of service factor.
7. Class F thermostat, one per phase.
8. Motor shall be inverter duty, 10:1 turndown (6-60 Hz), and meeting NEMA MG1 Part 31.
9. Manufacturers:
  - a. US Motors.
  - b. Marathon.
  - c. WEG.
  - d. Baldor.

- L. Shop Coatings: Coat pump and base in accordance with Section 09 91 50.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install pump in accordance with manufacturer's recommendations.

### **3.02 FIELD QUALITY CONTROL**

A. Field Testing:

1. Conduct test of the pumping equipment in the presence of the Engineer.
2. Testing Period: One hour minimum, or longer as may be required to determine compliance with the specifications.
3. Provide all power, gages, measurement devices, and other apparatus required for the testing.
4. Remove all testing equipment upon completion of testing.
5. Provide copies of all test data and results to Owner and Engineer.
6. Resulting pump capacities shall be within 5 percent of the previously supplied certified curves.
7. Replace or rework pumping equipment or components which fails to meet the specified requirements.

- B. Manufacturer's Field Services: Check pumps and motors for alignment (using laser alignment device) after installation and prior to field testing.

### **3.03 DISINFECTION**

- A. Disinfect all water contact surfaces prior to placement in service.
- B. Disinfectant: 200 ppm chlorine solution or dusting chlorine compound per AWWA C654.

### **3.04 DEMONSTRATION**

- A. Provide minimum of 4 hours of operator training after pumps are in service.

## **END OF SECTION**

**SECTION 43 21 30**

**NON-CLOG SUBMERSIBLE PUMPS**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. Furnish, install, and test submersible pumping units and accessories as indicated on the Drawings and as specified herein. Pumps shall be solids handling type.
- B. Four (4) submersible pumps will be installed throughout the facility.
  - 1. Two (2) Reclaim Tank - Backwash Waste
  - 2. Two (2) Reclaim Tank - Reclaim Water
- C. Related Sections
  - 1. Section 09 91 50 - Shop Painting
  - 2. Section 09 97 21 - Coating Systems for Water Facilities
  - 3. Section 26 05 05 - Basic Electrical Materials and Methods
  - 4. Section 26 24 19 - Motor Control
  - 5. Section 40 23 00 - Process Piping General Provisions
  - 6. Section 40 90 00 - Instrumentation and Control for Process System
  - 7. Section 44 44 00 - Process Equipment General Provisions

**1.02 DEFINITIONS**

- A. AFBMA: Anti-friction Bearing Manufacturers Association
- B. AISI: American Iron and Steel Institute
- C. ASTM: American Society for Testing and Materials
- D. FM: Factory Mutual
- E. HI: Hydraulic Institute Standards
- F. NEC: National Electrical Code
- G. NEMA: National Electrical Manufacturers Association
- H. NFPA: National Fire Protection Association

**1.03 DESIGN REQUIREMENTS**

- A. As presented below:

	<b>Backwash Waste Pumps</b>	<b>Reclaim Water Pumps</b>
Quantity	2	2
Design Condition (GPM)	100	220
TDH (total dynamic head)	25 feet	38 feet
Minimum Motor HP (nominal)	3	7.5
Minimum Pump Efficiency (%)	30%	30%
Maximum Motor RPM	1,750	1,750
Discharge Size (inches)	4	4

- B. The pumps shall meet the following future conditions:
  1. Backwash pumps shall produce 100 gpm at 24 ft Total Dynamic Head (TDH). Reclaim Water pumps shall produce 220 gpm at 35 feet TDH.
  2. Motor horsepower shall be 3 HP, minimum for Backwash pumps and 7.5 HP minimum for Reclaim water pumps. Motor speed shall be 1750rpm, maximum. The motor shall have a minimum service factor of 1.2.

**1.04 SUBMITTALS**

- A. Shop Drawings in accordance with Section 01 33 00 and include the following:
  1. Name of manufacturer.
  2. Size and model number.
  3. Performance curves.
  4. Certified performance curves.
  5. Detailed specifications and dimensions.
  6. Motor specifications.
  7. Installation guide.
  8. Printed warranty.
- B. Operating and Maintenance Data in accordance with Section 01 78 23.
- C. Certified Installation Inspection and Start-up Services.

**1.05 QUALITY ASSURANCE**

- A. The pumps shall be heavy duty, electric submersible centrifugal non-clog units non-overloading throughout the entire operating range of the pump suitable for continuous operation at full nameplate load while the motor is completely or totally submerged.

**1.06 WARRANTY**

- A. The pump manufacturer shall warrant the pumps, motors, and guide removal systems to the Owner against defects in materials and workmanship for a period of five years or 10,000 hours of operation under normal use and service.
- B. The pump manufacturer's warranty shall be in printed form and previously published as the manufacturer's standard warranty for all similar units manufactured. A copy of the warranty shall be provided to the Owner at system start-up.

**PART 2 PRODUCTS**

**2.01 MANUFACTURER/MODEL:**

A.

	<b>Backwash Waste Pumps</b>	<b>Reclaim Water Pumps</b>
Hydromatic	S4NRC	S4SD

B. Pre-approved Equivalent.

**2.02 COMPONENTS**

- A. Pumps:
  1. Each pump shall be of the sealed submersible type as manufactured by Hydromatic and be capable of pumping municipal sewage with spherical solids up to three inches in diameter. The castings (cord cap, motor housing, bearing housing, seal plate) shall be of high quality, ASTM A48, Class 30, gray cast iron. The pump discharge shall be fitted with 4-inch standard ANSI 125# flange, faced and drilled. All external mating parts shall be machined and Buna N

- rubber O-ring sealed on a beveled edge. Flat faces and gaskets shall not be acceptable. All fasteners exposed to the pump's liquids shall be of 300 series stainless steel.
2. The pump volute shall be ASTM Class 30 and shall consist of a centerline discharge on piece design. The passages are to be large enough to pass the same size solid as the impeller.
  3. Impeller shall be either ASTM Class 30 cast iron or ASTM Class 65 ductile iron. The impeller mounting is to be a slip fit onto a tapered shaft and a drive key. The impeller shall be attached to the shaft by a stainless steel fastener and impeller washer. The impeller is to be balanced to ISO1944 standards and is to be a two vane, or multi-vane, recessed vortex impeller.
  4. An upper radial bearing and lower thrust bearing shall be required in the motor. The upper bearing shall be heavy-duty radial single row ball bearing while the lower bearing shall be a double row heavy duty angular contact ball bearing of the thrust limiting design. Minimum of 50,000 hours of B10 bearing life for radial and thrust bearings while operating across entire hydraulic operating range of the pump. Bearings shall be lubricated for life from the factory and will be accomplished through the non-toxic, low viscous, dielectric oil in the frame
  5. The pump/motor shaft shall be 0.002" at BEP. The rotor and stator in the motor housing shall be separated and protected from the pumped liquid by an oil-filled seal housing incorporating two (2) John Crane seals. Both lower and upper seals shall be a Carbon-Ceramic faces and be replaceable without disassembly of the seal chamber and without the use of special tools. Seals shall be mounted in tandem. The seal housing/chamber shall be equipped with two moisture sensing probes installed between the seals. Mechanical seals must be locally available and nonproprietary.
- B. Pump Shaft:
1. Provide an AISI type 416 stainless steel pump shafts.
  2. The pump and motor shafts shall be the same unit.
  3. Couplings are not acceptable.
- C. Impeller:
1. The impellers shall be gray cast iron, dynamically balanced, 2 vane, non-clogging design having a long through let without acute turns.
  2. Impeller shall be keyed to the shaft. Securing of the impeller shall be accomplished via a special taper action, locking device.
  3. A wear ring system shall be used to provide efficient sealing between the volute and suction side of the impeller. Each pump shall be equipped with a nitrile rubber coated steel or bronze ring insert that is drive fitted to the volute inlet.
- D. Motor:
1. The pump motors shall be a squirrel-cage, induction, shell type design, housed in a NEMA B type, oil-filled watertight chamber. The stator windings and leads shall be insulated with moisture resistant Class H insulation rated for 155°C (311°F). The stator will be dipped and baked three times in Class F varnish and heat-shrunk fitted into the stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty, capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum.
  2. Thermal sensors used to monitor stator temperatures shall be imbedded in the stator lead coils to monitor the temperature of each phase winding and set to open at 125 degrees C (260°F). These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and connected to the control panel to stop the pump and signal an alarm condition. A float leakage sensor shall be provided to detect water in the stator chamber. These shall work in conjunction with the controls to signal an alarm condition. The submersible pump manufacturer shall provide the over/temp/moisture sensor control and monitoring unit to the Owner.
  3. The junction chamber shall be hermetically sealed from the motor by an elastomer O-ring seal.
  4. Motors shall be 480 volt, 3-phase, 60 Hz.
  5. The pump shaft shall rotate on two bearings rated for B10 life of 40,000 hours at anticipated axial and radial loading. Motor bearings shall be permanently greased. The upper bearing shall be a single roller bearing and the lower bearing shall be a two-row angular contact bearing.
  6. Provide two totally independent mechanical shaft seal assemblies, installed in tandem, each with its own independent spring system acting in a common direction. The seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower seals

- shall be tungsten-carbide both faces. The upper seal unit shall contain one positively driven rotating carbon ring installed in an oil-filled chamber with positive anti-leak sealing drain and inspection plug. Each seal interface shall be held in contact by its own spring system. The seals shall not require routine maintenance or adjustment or depend on direction of rotation for sealing. Seals shall be capable of being easily inspected and replaced. Shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower units will not be acceptable.
7. Motor shall be oil filled; seal chambers shall contain only ecologically safe paraffin base oil.
  8. Pump shall be capable of running dry while out of pumped liquid for extended periods without damage.
  9. The power cable shall be sized according to the NEC and ICEA standards. It shall be of sufficient length to reach the junction box without splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The cable entry to the motor shall consist of a single cylindrical elastomer grommet flanked by washers. The motor and cable shall be capable to continuous submergence under water without loss of watertight integrity to a depth of 65 feet.
  10. Recycle pump motor shall be designed for operation with a variable frequency drive. Motors shall be rated inverter duty per the requirements of Division 26

### **2.03 ACCESSORIES**

- A. Power Cable:
  1. The pumps shall be supplied with power cable sized according to NEC standards and shall be of sufficient length to reach the motor terminal housing without the need of any splices.
  2. The outer jacket shall be oil resistant chloroprene rubber.
- B. Discharge Connection Base
  1. Sealing of the pumping unit to the permanently mounted discharge connection shall be accomplished by a simple downward motion of the pump guided to and wedged tightly against the discharge connection. Final connection shall insure zero leakage between pump and discharge connection flange.
  2. No portion of the pumping unit shall bear directly on the sump floor or pedestal.
- C. Pump Removal System:
  1. Provide a pump removal system consisting of galvanized pipes to guide the pumping unit to the discharge connection elbow where shown on the Drawings. Provide anchorage for guides to concrete slab.
  2. Provide 316 stainless steel lifting cable of sufficient length to permit raising the pump for inspection and removal.
  3. The working load of the lifting system shall be 50 percent greater than the pump unit weight.
- D. Cable Holder and Safety Hooks:
  1. Furnish PVC coated cable holders to hold power cables and float switches.
  2. Provide stainless steel safety chain hooks for lifting chain or cable.

## **PART 3 EXECUTION**

### **3.01 DELIVERY OF EQUIPMENT**

- A. Delivery of equipment shall be coordinated with the requirements of the Contractor.

### **3.02 INSTALLATION**

- A. Install equipment in accordance with manufacturer's recommendations and as shown on Drawings.
- B. Equipment manufacturer to furnish necessary anchor bolts, nuts, washers, gaskets and anchor bolt templates.
- C. Install all anchors in accordance with certified prints supplied by equipment manufacturer.

### **3.03 DISINFECTION**

- A. After all the potable water process equipment, piping, and filters are completed, they shall be disinfected in accordance with the Virginia Department of Health Standards
- B. Perform disinfection of all process piping and equipment in accordance with the following:
  - 1. AWWA C651.
  - 2. AWWA C653.
- C. Hold chlorine solution in pipe for a minimum of 24 hours.
  - 1. Initial Dosage: 50 ppm minimum.
  - 2. Residual Dosage After Hold Period: 10 ppm minimum.
- D. Operate all valves and other equipment during disinfection to ensure complete coverage.
- E. Flush system with potable water within 24 hours after disinfection is completed.
- F. After flushing, obtain 2 sets of samples taken a minimum of 24 hours apart.
  - 1. Take sample sets from various representative areas of the piping.
  - 2. Minimum Samples Required: 2.
- G. Perform coliform and chlorine residual tests on each sample.
- H. Rechlorinate if any samples test positive for coliform.
- I. After satisfactory test results are achieved, the piping may be connected to the potable water system.

### **3.04 SYSTEM AND EQUIPMENT STARTUP**

- A. Conform to the requirements of Section 01 75 00.
- B. The manufacturer or single source supplier of equipment included in each section shall inspect the completed installation; make all necessary adjustments, corrections, or modifications prior to start-up. See Section 44 44 00.
- C. Provide written certification that check-out services have been completed and 1 week notice prior to start-up and demonstration.
- D. Place various items of equipment into operation, along with related piping and control systems, at times acceptable to Owner. After satisfactory start-up of these systems and their related equipment, they will remain in continuous or intermittent operation as required by the Owner.
- E. All equipment and accessories shall be adjusted and calibrated prior to any start-up and any equipment placed into temporary operation prior to Final Completion of the total Project shall be readjusted and/or recalibrated as necessary.
- F. Contractor shall supervise, control, and be responsible for operation and maintenance of new equipment and/or systems during start up.
- G. No system start-ups will be held on holidays, Fridays, or the day before a holiday.

### **3.05 DEMONSTRATION AND TRAINING**

- A. Provide factory trained serviceman to instruct the Owner's personnel in the proper operation and maintenance of the equipment and certify to the Engineer that system is installed and operating properly, refer to Sections 01 75 00 and 40 05 00.
- B. Following completion of successful equipment start-up, the Contractor shall arrange for a factory representative and installer of each operating piece of equipment and other work requiring regular or



continuing maintenance, to meet at Site with Owner's personnel to provide necessary basic instruction in proper operation and maintenance of entire work. Where installers are not experienced in required procedures, include instruction by manufacturer's representatives.

- C. For each piece of operating equipment, the factory representative and installer shall provide two separate training sessions to the Owner's operations and maintenance staff. The two training sessions shall be separated in time by at least 1 week (7 days) and shall be arranged to meet the schedules of the Owner's operations and maintenance staff.
- D. Each training session shall be inclusive of a minimum 4 hours on-site instructional time. All travel time and costs necessary to perform each training session shall be considered as additional and incidental to four hours of on-site instructional training time.
- E. The training session time shall be separate and distinct from the time spent on equipment start-up.
- F. Contractor shall coordinate the schedule for each training session a minimum of 2 weeks (14 days) ahead of schedule.
- G. All final copies of the Operation & Maintenance manuals for each piece of operating equipment shall be delivered to the Engineer a minimum of 1 week (7 days) prior to scheduling the initial training session.
- H. At a minimum, each training session shall include the following:
  - 1. Utilize operation and maintenance manuals as basis for instructions.
  - 2. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
  - 3. Include a detailed review of the following items:
    - a. Maintenance manuals.
    - b. Record documents.
    - c. Spare parts and materials.
    - d. Tools.
    - e. Lubricants.
    - f. Fuels.
    - g. Identification systems.
    - h. Control sequences.
    - i. Hazards.
    - j. Cleaning.
    - k. Warranties.
    - l. Maintenance agreements and similar continuing commitments.
  - 4. Manufacturer's representative shall demonstrate the following procedures to Owner's personnel prior to date of final inspection:
    - a. Startup.
    - b. Shutdown.
    - c. Emergency operations.
    - d. Noise and vibration adjustments.
    - e. Safety procedures.
    - f. Economy and efficiency adjustments.
    - g. Effective energy utilization.
    - h. Troubleshooting.
    - i. Maintenance.
- I. Prepare and insert additional data in operations and maintenance manuals if need for additional data becomes apparent during instructions.

**END OF SECTION**

## SECTION 43 22 52

### MAGNETIC FLOWMETERS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. This section describes the requirements for electro-magnetic averaging flowmeters and associated transmitter.
- B. Related Sections
  - 1. Section 26 05 05 - Basic Electrical Materials and Methods
  - 2. Section 40 23 00 - Process Piping General Provisions
  - 3. Section 44 44 00 - Process Equipment General Provisions
  - 4. Section 40 90 00 - Instrumentation and Control for Process Systems

##### 1.02 PERFORMANCE REQUIREMENTS

- A. Provide instruments capable of meeting the following performance requirements when installed in accordance with the manufacturer's recommendations:
  - 1. Measured accuracy within plus or minus 1.0 percent of rate, standard; optional models plus or minus 0.5 percent of rate, for velocities greater than 0.1 meter/sec (0.33 feet/second).
  - 2. Measured repeatability within plus or minus 0.1 percent of stated accuracy.
  - 3. Response time, to reach 90 percent of measurement value, adjustable from 1 to 100 seconds.
  - 4. Warm up time not to exceed 10 minutes.
  - 5. Velocity rangeability, 50:1, 0.66 to 33 feet/second. Normal operating velocities 1 to 10 feet/second.
  - 6. Electronics ambient temperature 15 to 131 degrees F.

#### PART 2 PRODUCTS

##### 2.01 PRIMARY ELEMENT

- A. Meet the following requirements unless noted otherwise on the instrument schedule.
  - 1. Flowmeter body and flanges: Carbon steel.
  - 2. Epoxy polyester paint.
  - 3. Silicone rubber housing sealant.
  - 4. Electrodes: 316 SS.
  - 5. Liner: Polyurethane meeting NSF requirements.
  - 6. Process connection: flanges, rated 150 psig.
  - 7. Maximum fluid pressure 300 psig.
  - 8. Submergence rated 15 feet.
  - 9. Suitable for liquids with conductivity greater than 10 micro-siemens/cm.
  - 10. Maximum fluid temperature with integral electronics, 176 degrees F.
  - 11. Maximum fluid temperature with separate electronics, 302 degrees F.
  - 12. Support minimum separation of 30ft from primary element to transmitter where separate electronics are indicated.
  - 13. Stainless steel grounding rings shall be furnished.
- B. Nominal size shall be as identified in the Instrument List.

## 2.02 AMPLIFIER/TRANSMITTER

- A. Meet the following requirements unless noted otherwise on the instrument schedule.
1. Design: Microprocessor based technology electronics
    - a. Pulsed D.C. system powers flow tube coils.
    - b. Self-diagnostics aids to maintenance and service.
    - c. Modular construction with plug-in circuit cards and options.
    - d. Continuous automatic re-zeroing calibration.
    - e. Variable damping capability with an adjustable range of 0.1 to 200 seconds.
    - f. Adjustable low flow cutoff circuitry locks output signal at 4ma and provides contact signal output for alarm.
  2. The amplifier/transmitter shall be remotely mounted from the primary element.
  3. The amplifier/transmitter shall be capable of automatic dual range switching and bi-directional flow indication.
  4. Display:
    - a. Provide simultaneous digital indication of flow rate in percent of span or engineering units and totalization in engineering units.
    - b. Totalizers shall be provided for forward, reverse and differential flow.
    - c. Characters 6mm or larger.
    - d. All flow meters shall have remote converters.
  5. Outputs:
    - a. Option 1
      - 1) Isolated 4-20ma current into 600 ohm signal proportional to flow range selected for each direction.
      - 2) Open collector scaleable pulse output rated 30VDC for each direction.
    - b. Option 2
      - 1) Isolated 4-20ma current into 600 ohm signal proportional to flow range selected.
      - 2) Open collector scaleable pulse output rated 30VDC.
      - 3) Bi-directional flow indication.
  6. Alarms: High and low; adjustable set-points; isolated output SPDT contacts, 2amp 120vac.
  7. Enclosure: NEMA 4 rated enclosure.
  8. Incoming Power: 120Vac 60Hz, 50 watts, or less
  9. Signal: Manufacturer's sensor cable connection direct from sensor to instrument housing via flexible weather-proof conduit.
  10. Provide separate conduits for signal and power wiring to the meter and between the transmitter and control panel. Meter shall be grounded in accordance with manufacturer's instructions.

## 2.03 SCHEDULE

<u>Location</u>	<u>Size</u>	<u>Type</u>	<u>Tag</u>
Well No.19 Discharge - (Raw water)	12-inch	Toshiba ANSI 150 Flanged Magmeter	FE-WP-19-1
Back Rate Control Flow Meter - backwash waste line	4-inch	Toshiba Remote Detector Flanged Magmeter	FE-BWW-1
Filter Backwash Discharge Line 1 - In vault	4-inch	Toshiba Remote Detector Flanged Magmeter	FE-BWS-1
Filter Backwash Discharge Line 2 - In vault	4-inch	Toshiba Remote Director Flanged Magmeter	FE-BWS-2
Backwash Reclaim Line	6-inch	Toshiba Remote Mag Flow Tube Polyurethane Liner, 316 SS Electrodes and Ground Rings Flanged Magmeter	FE-BWR-1

## 2.04 MANUFACTURERS

- A. Manufacturers:
1. Toshiba Model GF632
  2. Or equal preapproved by engineer

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Provide and install valve and all hardware required for sensor installation and removal with pipe full and under pressure.
- B. Verify exact mounting location and orientation with factory trained field representative.
- C. Never install a meter where gas can collect or a line can self-drain when flow stops.
- D. Install meters where the pipe remains full at all times.
- E. Install separate conduits for signal and power wiring to the meter and between the transmitter and control panel.
- F. Install the transmitter remotely from the primary element.
- G. Ground the meter in accordance with manufacturer's instructions.
- H. Install 1000 feet of Toshiba electromagnetic flow meter cable. Madison Water Utility shall keep the extra cable not used.
  - 1. 1000 feet of Toshiba Electromagnetic Flow Meter Cable Single Cable, Outside Diameter 0.404-inch.
  - 2. 1000 feet Toshiba Electromagnetic Flow Meter Cable Excitation Cable, Outside Diameter 0.264-inch.
  - 3. (5) Toshiba Remote Converter Electronics:
    - a. 100-240 VAC 50/60 Herzt.
    - b. 110Vdc.
    - c. HART Protocol with (2) Digital Outputs and (1) Digital Input.

**END OF SECTION**

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## SECTION 44 44 15

### GAS CHLORINATION SYSTEM

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Work Included: This section includes furnishing, installing, and placing into successful operation one chlorination system. The chlorination system shall be designed to deliver against available discharge pump and shall include one rotameter and injector assembly. The equipment and appurtenances shall be furnished by the same supplier.

##### 1.02 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Provide for the conveyance of chlorine gas under vacuum from the vacuum regulators to the ejector-check valve assembly via automatic flow proportioned control.
  2. Entire system can be vacuum checked in the field.
  3. Common system shall be equipped as follows:
    - a. Cylinder-mounted regulator.
    - b. Latching Type Switchover System.
    - c. Feed piping and valves.
    - d. Feed point.
    - e. Chlorine gas detector.
    - f. Insect screen.
    - g. Signage.
  4. The primary chlorine feed system (Normal filter operation) shall include the following designated components:
    - a. Automatic valve.
    - b. Remote meter panel with auto valve.
    - c. Ejector assembly.
    - d. Solenoid loop (water supply feed).
    - e. Associated process piping, fittings and valves.
  5. The secondary chlorine feed system (filters in backwash production mode and pressure sustaining valve energized) shall include the following designated components.
    - a. Remote meter panel.
    - b. Ejector assembly.
    - c. Chlorine booster pump.
    - d. Motor.
    - e. Solenoid valve.
    - f. Associated process piping, fittings and valves.

##### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Submit Shop Drawings indicating system schematics, equipment locations, details, and control schematics.
- C. Product Data: Submit Product Data indicating chemical treatment methods, chemicals, and equipment; manufacturer's installation instructions.
- D. Submit reports in accordance with Section 01 75 00:
  1. Report indicating start-up of treatment system is completed and operating properly.
  2. Report indicating analysis of system water after treatment.

3. Report indicating analysis of fluoride residuals measured immediately after each injecting point and post filtration.
- E. Operation and Maintenance Manuals: Prior to start-up, furnish operation and maintenance manuals in accordance with Section 01 77 00.

#### **1.04 WARRANTY**

- A. All equipment, unless otherwise stated, shall be warranted by the manufacturer for 1 year from the date of start-up. Note: Chlorinator shall include a 3-year warranty and a lifetime warranty shall be included on the diaphragm, body bolts, springs (2), inlet adapter and vent plug.

#### **1.05 QUALITY ASSURANCE**

- A. Single Source Responsibility: All components to be provided by one supplier.
- B. Qualifications:
  1. Manufacturer/supplier shall have minimum 5 years documented experience in the manufacture and installation of gas chlorination systems.
  2. Manufacturer/supplier shall maintain full-time service staff.
- C. Regulatory Requirements: Materials and equipment provided in this Section shall comply with the recommended practices and standards for the Chlorine Institute, Inc.

### **PART 2 PRODUCTS**

#### **2.01 COMPONENT FABRICATION**

- A. All devices in this section shall be cord plugged to a wall outlet.
- B. Vacuum Regulators:
  1. Number required: 2.
  2. Mount directly on gas valve via positive yoke type gasket connection.
  3. Provide vacuum control by spring opposed diaphragm regulator that closes tight upon loss of vacuum.
  4. Equip as follows:
    - a. Gravity Actuated, loss of gas indicator.
    - b. 50 pounds/day gas flow meter.
    - c. Gas direction indicator.
  5. Pressure relief:
    - a. Pressure relief valve, spring-loaded, diaphragm actuated.
    - b. Vent gas at vent relief valve (SPR-1).
  6. Body bolts to be titanium.
  7. Vacuum fittings to include PVDF wing nut fittings.
  8. Fiberglass reinforced ABS front and back body with carbon black to inhibit UV degradation.
  9. Ultra-thick yoke coating (ECTFE).
- C. Latching Style Switchover System (built into the vacuum regulators):
  1. Provide 1 latching style switchover system.
  2. Capacity: 100 pounds/day.
  3. Vacuum operated switching from empty to full source.
  4. Manual reset required.
  5. Preset at factory.
- D. Ejector/Check Assembly:
  1. Quantity: 2.
  2. Discharge gas/ejector water solution to point of application.
  3. Equip with standard dual check valves to prevent backup into regulators.

4. Automatic gas flow shut-off upon loss of water (vacuum).
  5. Maximum feed rate: 100 pounds/day.
  6. Teflon diaphragm as secondary check valve.
- E. Main line feed point (corporation stop):
1. Provide 1-inch NPT ball valve main connection complete with diffuser.
  2. Product: Saf-T-Flo EB-132-B-H or pre-approved equal.
  3. Solution tube insertion length shall be such that chlorine is injected into the static mixer at 1/3 diameter of the water pipe.
  4. The solution tube tip shall be the manufacturers standard tip configuration.
  5. The flexible hose assembly shall be of a material compatible with the chemical being fed and the working pressure in the feed system.
- F. Automatic Gas Feeder
1. Provide 1 wall-mounted automatic gas feeder system with electronic micro-processor-based controller.
  2. Operation: Vacuum operated and shall convey gas under vacuum from vacuum regulator to ejector check valve assembly to maintain complete system safety.
  3. Chlorinator shall be equipped to feed a minimum range of 0 to 100 pounds per 24 hours, with a 20:1 feed range and automatic cylinder switchover.
  4. Provide additional rotameters to feed up to 100 pounds per 24 hours.
  5. System discharge pressure:
    - a. Normal filter mode: Pressure will be variable between 5 to 10 psi.
  6. Feed water pressure will vary from 60 psi to 70 psi (suction side of chlorine booster pump is located on the downstream side of the high service pumps.) This same pressure will be available for the normal operation model when chlorine booster pump will remain unused.
    - a. Flow proportional chlorinator shall be designed for automatic proportional control from a 4-20mA DC flow signal. Unit shall operate with an accuracy of plus or minus 5 percent over a 20:1 feed range.
    - b. 120V, single-phase, 60 Hz power supply.
  7. Equip as follows:
    - a. Vacuum gage in the vacuum system to indicate proper operation of the equipment.
    - b. Vent to the atmosphere outside the chemical feed room.
    - c. Dual check valves preventing the backflow of injector water into chlorine gas lines.
  8. All components of the chlorinator, including microprocessor controller, shall be panel-mounted, maximum panel width 24 inches.
  9. The automatic gas feeder provided shall be a Hydro Omni Valve Model WPOV-110-3100M320M (Product #57263) 100 PPD w/ Vacuum Monitor.
  10. The chlorine booster pump will operate in Backwash Mode to provide the additional pressure.
- G. Digital Chlorine Vacuum Alarm Switch
1. Number Required: 1.
  2. Type: Low and High Vacuum Alarm.
  3. Enclosure: Fiberglass, NEMA 4X.
  4. Power: 120 VAC.
  5. Alarm Relays:
    - a. NO\NC type.
    - b. 240 VAC at 5A resistive.
    - c. 115 VAC at 5A general use.
    - d. 30 VDC at 5A general use.
  6. Analog Output:
    - a. Voltage: 0 to 3 VDC.
    - b. Amperage: 0 to 3 mA DC.
  7. Indicators:
    - a. Vacuum: 3-digit digital LED display.
    - b. Alarms: 3 LED indicators (High, Low and Latch).
    - c. Polarity: 1 LED indicator for pressure.
  8. Acromet Model VAS-3".



- H. Scale:
1. Quantity: one scale unit that weighs two independent 150-pound cylinders.
  2. Electronic Type.
  3. Platform: Non-corrosive molded fiberglass reinforced thermoplastic.
  4. Provide for two 150-pound cylinders.
  5. Load cell: Electronic, stainless steel.
  6. 4-20 mA output.
  7. Cylinder chaining bracket:
    - a. Provide for each cylinder.
    - b. Include integral tool rack.
  8. Warranty: 5 years on all parts.
  9. Force Flow Model GR150-2 with 2-Channel Solo G2 Display.
    - a. Force Flow Electronic Dual Chlor-Scale 150
    - b. 2-Channel Solo G2 Digital Indicator with 4-20mA Outputs
    - c. PVC Platforms
    - d. Chain Brackets
    - e. Newly Designed Electronic Shear Beam Load Cells with 10 feet of cable.
  10. Dual 3-1/2-digit display, no equal.
  11. NEMA 4X, UL approved enclosure.

I. Chlorine Booster Pump:

1. Pump:
  - a. Quantity: 1.
  - b. Vertical multi-stage design.
  - c. Discharge pressure (back pressure):

Booster Pump	Discharge Pressure	Supply Pressure
Well 19	5-10PSI	Equal to discharge of injector

- d. Operate at continuous temperatures of up to 250 degrees F and working pressures of 300 psi.
- e. Secure impeller directly to shaft by splined shaft.
- f. High temperature mechanical seal assembly, with tungsten carbide seal faces mounted in stainless steel components.
- g. Cast iron components:
  - 1) Suction/discharge chamber.
  - 2) Motor stool.
  - 3) Pump shaft coupling.
- h. Stainless steel components:
  - 1) Impellers.
  - 2) Pump shaft.
  - 3) Diffuser chambers.
  - 4) Outer discharge sleeve.
  - 5) Impeller seal rings/ring retainers.
  - 6) Intermediate and lower shaft bearings: Tungsten carbide and ceramic.
2. Motors:
  - a. Non-overloading when operating on specified curve.
  - b. 2.0 HP.
  - c. 208-230/460 VAC, 3-phase.
  - d. Open drip-proof design with NEMA C-face.
  - e. Operating speed: Nominal 3,500 rpm.
  - f. Service factor: 1.15.
  - g. Peerless Series C, or equal, provided by Grundfos.
  - h. Pump Size Condition: Max pressure/flow: 16 gpm @ 50 psi (boost).

J. Chlorine Analyzer(s)

1. Provide two chlorine analyzers as shown on the drawings. Connect to at existing sample points

2. The chlorine analyzer shall employ a DPD colorimetric method of measurement using DPD indicator and a buffer solution.
3. The analyzer shall be capable of measuring free or total residual chlorine by changing the indicator and buffer solutions.
4. A measurement shall be taken every 2.5 minutes and results displayed by a three-digit LCD readout in the range of 0 to 5 mg/L.
5. The analyzer shall be designed for 30 days unattended operation and use only 473 mL of each reagent per month. An additional month's supply of free chlorine reagents shall be provided.
6. Provide a sampling conditioning kit. Provide pressure reducing valve as required to meet manufacturer's maximum pressure requirements.
7. The analyzer shall operate with an LED light source with a peak wavelength of 510 nm.
8. The instrument shall measure a sample blank before each sample measurement to provide automatic zero reference to compensate for sample color and turbidity and changes in light intensity resulting from voltage fluctuations or light source aging.
9. The instrument shall provide a minimum detection limit of 0.035 mg/L or better, precision better than  $\pm 5$  percent or 0.005 mg/L as Cl<sub>2</sub>, and accuracy better than  $\pm 5$  percent or 0.035 mg/L as Cl<sub>2</sub>.
10. The analyzer shall be microprocessor controlled and provide a 4-20 mA output as well as two alarm relay outputs.
11. The microprocessor shall provide self-diagnostic functions accessible through an alphanumeric, menu driven keyboard.
12. Recorder span minimum and maximum values shall be operator programmable at the menu driven keypad over the entire operating range.
13. The chlorine analyzer shall be housed in a NEMA 4X rated, ABS plastic enclosure designed for wall mounting.
14. The enclosure shall have two clear polycarbonate windows for viewing the measurement readout and reagent levels.
15. Power requirements shall be 110-115/230 Vac, 50/60 Hz, switch selectable, 95 VA maximum. Provide power cord with unit.
16. The instrument shall be the Model CL17sc Chlorine Analyzer and SC4500 Controller, manufactured by the Hach Company.
17. Accessories
  - a. One-month additional supply of free chlorine reagents.
  - b. Provide pressure reducing valve as required to meet manufacturer's maximum pressure requirements.
  - c. One sample conditioning kit.
18. Warranty: the product shall include a one-year warranty from the date of installation.

K. Chlorine Leak Detector:

1. The alarm module shall be microprocessor controlled allowing full programmability of the modules two levels of alarm and calibration levels. No internal adjustments of internal potentiometers will be acceptable.
2. Each signal transmitting input shall include an analog 4-20 mA output, two common alarm relays, and discrete 6 discrete alarm relays.
3. The alarm module components shall be housed within an approved polycarbonate NEMA 4X enclosure.
4. Indication of present gas concentration, zero, span, and full-scale range values shall be displayed using a 3-digit LCD.
5. The alarm module shall be capable of accepting 120 Vac, 60 Hz, single-phase power.
6. An integral horn shall be included to provide an audible indication of alarm condition.
7. The sensor shall be an electrochemical device that senses chlorine gas and requires no maintenance.
8. Provide cable with digital processor/sensor of sufficient length to reach installed location of sensor in chemical room. Provide junction boxes, if required by manufacturer, for cable lengths that are longer than the standard cable length.
9. The chlorine leak detector shall be Scott Freedom Series 5000, Rock Solid, 5 ppm single-channel alarm module with Scott series 5000 plus controller or approved equal.

L. Emergency Shut Off System:

1. Scope:
  - a. Provide 1 emergency shut-off system for two 150-pound chlorine cylinders.
  - b. Emergency shutoff system shall close the chlorine cylinders if a leak is detected.
  - c. The emergency shut off systems shall be comprised of up to 2 electrically driven actuators that act directly on 2-cylinder valve stems.
  - d. The actuators shall mount upon the cylinder valve and yoke assemblies by means of a clamping mechanism and a valve stem coupling so as to be removable during cylinder changes.
  - e. Each actuator shall deliver 50 feet per pound of closing torque to the valve stem upon receipt of a shutdown signal.
  - f. Each actuator shall be powered only in the closing direction with provision for manual override in either the OPEN or CLOSED direction.
  - g. Power for each actuator shall be supplied by an uninterruptable 12V battery power supply and control system.
2. Actuator Design: Each actuator shaft shall couple to the valve stem and provide an extension through the actuator such that a standard chlorine wrench may be applied to the extension to manually operate the valve while the actuator is in place.
3. Actuator Components:
  - a. Motor Driver: Power shall be provided by 12 VDC electric motors acting through a gear reduction system.
  - b. Clutch and Shaft: Constructed of materials suitable for the chlorine environment.
  - c. Valve Stem Coupling: The element that couples the driven shaft to the valve stem shall be designed to accommodate slight misalignment of the actuator shaft with the axis of the valve stem without restricting rotation.
  - d. Clamp/Frame:
    - 1) The clamping mechanism for yoke mounting shall require no tools for installation on the valve and valve yoke.
    - 2) Adapters shall be provided to unitize the actuator with regulator clamping systems commonly used in the industry.
    - 3) All clamp and frame components shall be coated with fusion bonded polyester for corrosion resistance.
  - e. Sealing Devices:
    - 1) Shaft entrances to the actuator mechanism shall be sealed with double O-ring seals of Viton and/or Teflon.
    - 2) The motor canister and main enclosure will be sealed with static, Viton O-ring seals.
4. Control Panel Design:
  - a. The controller shall be contained within a single electrical enclosure of NEMA 4X rating.
  - b. All cables, connectors, switches and fittings shall be of a similar rating to resist the chemical environment.
  - c. The actuators shall have a dedicated power source (battery) and microprocessor controller. Electrical power shall be delivered to each actuator by means a flexible cable.
  - d. Control panel:
    - 1) Indicator lights to display the status of key system elements.
    - 2) Accept signals from sources such as gas detectors, remote station alarms, seismic or fire sensors.
    - 3) Manual switches to trigger each actuator to automatically close each cylinder or ton container valve connected to the system.
    - 4) Capable of accepting input signals to initiate either simultaneous or independent operation of each actuator and valve.
5. Control Panel Components:
  - a. Control Circuitry:
    - 1) An electronic circuit board in the control panel shall contain a microprocessor programmed to precisely control the valve closing cycle and the torque applied to the valve stem.
    - 2) The panel shall be controlled by wires using quick connectors to digital terminals of the SCADA PLC.

- b. Battery and Charger:
  - 1) The battery shall be of the gel-cell, lead-acid type rated at 7 ampere-hours.
  - 2) The charging system shall provide a variable controlled charge current that is temperature compensated to optimize battery performance and service life.
- c. Status Lights:
  - 1) The control panel enclosure shall have a membrane panel in the front cover where the operator may observe the status lights.
  - 2) Provide status lights for each respective system are as follows:
    - a) Charge Power.
    - b) Armed/Ready.
    - c) Battery Low.
- d. Input Signals:
  - 1) The control panel shall contain a DIN rail to accept multiple incoming signals for either simultaneous or individual actuator operation.
  - 2) External signals shall consist of a "NORMALLY OPEN or NORMALLY CLOSED" dry contact, to initiate the actuator.
- e. Output Signal:
  - 1) After initiation of the actuator, the control system shall provide a high voltage output signal (5.0A at 115V DC/AC) and a low voltage output signal (0.2A at 24V DC/AC) to indicate actuator initiation and/or completion.
  - 2) These output signals may, in turn, be employed to trigger other relays or alarms.
- f. Testing: Mount a "TEST" button externally on the control panel to provide a full cycle test of each individual actuator.
- 6. Power Requirements: 115 VAC.
- 7. Furnish one spare battery.
- 8. Emergency shut-off system shall be Halogen Gemini System, manufactured by Halogen Valve Systems, Inc., or prior approved equal.

## 2.02 ACCESSORIES

- A. Tubing, Vacuum and Testing: Polyethylene.
- B. Wall Bracket for spare cylinder storage, capable of securing four 150-pound cylinders.
- C. Valves, PVC piping and conduits, and fittings as required for complete installation.
- D. Insect screen.
- E. Signage:
  - 1. Text: "Danger Chlorine".
  - 2. Aluminum with stenciled painted lettering.
  - 3. Finish: Backed-on enamel.
- F. Provide 2 Y-strainers for the water supply line.
- G. Provide necessary 2-inch PVC carrier piping, polyethylene tubing sized to match pump and injector, couplings, valves, and fittings to connect chlorine feeder to the point of chlorination. Provide necessary vent tubing with stainless steel screened outlet to outside from chlorinator.
- H. Provide manifold to connect two cylinders to chlorinator. See drawings.
- I. Provide water pressure gauges of proper range with shutoff valve for chlorinator.
- J. Provide chlorine leak detection kit that includes a plastic bottle of ammonium hydroxide, 56 percent solution.
- K. Provide one NIOSH-approved, self-contained, pressure-demand compressed air breathing unit with 30-minute breathing capacity consisting of medium Hycar facepiece with spring-loaded exhalation

valve, large nose cup, pressure-demand regulator, audible low-pressure warning device, compressed air cylinder and harness, Wallace & Tiernan, MSA, or equal.

- L. Provide wall cabinet with mounting bracket to store breathing unit. The breathing unit shall be stored in a room separate from the chlorine storage room.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install equipment and accessories in accordance with manufacturers' instructions.
- B. Install vent lines from the regulators to the building exterior.
- C. Install insect screen on exterior end of vent line.
- D. Install "Danger Chlorine" sign on chemical room door exterior.

### **3.02 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Services:
  - 1. Inspect and approve final system installation prior to start-up.
  - 2. Provide minimum 2 man-days and 2 trips to site for supervision of installation, start-up, and operator training.
  - 3. Provide 1 hour per month for further instruction on maintenance and system operation for the first year of operation.

**END OF SECTION**

## SECTION 44 44 39

### FLUORIDE FEED EQUIPMENT

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Furnish and install complete chemical feed system for injecting fluoride.
- B. Work Included: This section includes furnishing, installing, and placing into successful operation one complete fluoridation system. Fluoridation system shall include a day tank with scale, and peristaltic positive displacement metering pump. The equipment and appurtenances shall be furnished by the same supplier.

##### 1.02 REFERENCES

- A. WDNR NR 811.
- B. Recommended Standards for Water Works "Ten State Standards", 1997 Edition.
- C. NSF - NSF International, Ann Arbor, MI.

##### 1.03 SUBMITTALS

- A. Refer to Section 01 33 00.
- B. Shop Drawings: Indicate system schematics, equipment locations, details, and control schematics.
- C. Product Data: Submit manufacturer's Product Data indicating chemical treatment methods, chemicals, equipment, and installation and maintenance instructions.
- D. Submit reports in accordance with Section 01 75 00 and include:
  - 1. Report indicating start-up of treatment system is completed and operating properly.
  - 2. Report indicating analysis of system water after treatment.
  - 3. Report indicating analysis of fluoride residuals measured immediately after each injecting point and post filtration.
- E. Operation and Maintenance Manuals: Prior to start-up, furnish operation and maintenance manuals in accordance with Section 01 78 23.

##### 1.04 DEFINITIONS

- A. PVC: Polyvinyl chloride.
- B. NPT: National pipe thread.

##### 1.05 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide equipment by one supplier.
- B. Regulatory Requirements: Materials and equipment provided in this Section shall comply with the recommended practices and standards of NSF International.

## 1.06 WARRANTY

- A. All equipment, unless otherwise stated, shall be warranted by the manufacturer for 1 year from the date of start-up.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Use common components to the greatest degree possible to simplify spare parts inventory and service.

### 2.02 TANKS

- A. Manufacturers:
  - 1. Snyder
  - 2. Polyprocessing
  - 3. Assmann
- B. Description:
  - 1. Number: 1.
  - 2. Volume: 160-gallon.
  - 3. Diameter: 35-inch maximum.
  - 4. Material: Polyethylene, complying with NSF requirements and compatible with intended chemical.
  - 5. Construction: 1-piece seamless construction with ultraviolet inhibitor capable of storing liquid chemicals up to a specific gravity of 1.90.
  - 6. Calibration: 1-gallon increments.
  - 7. Closed top with threaded lid.
  - 8. Tank and all wetted parts shall be chemically compatible with fluoride solution.
- C. Equip as follows:
  - 1. 7-inch threaded cap
  - 2. 1-1/2-inch PVC dip leg with suction tubing and strainer inside tank.
  - 3. 1-1/2-inch NPT bulkhead on top of tank for metering pump pressure relief return. Install with lines through bulkhead with grommet to prevent vapor escape.
  - 4. 2-inch NPT bulkhead for venting the tank.
  - 5. Metering pump pressure relief return(s).
  - 6. Secondary containment basin
    - a. Min. capacity shall be sized to fully contain the volume of the feed tank.
    - b. Manufactured of high-density polyethylene materials. Materials shall be compatible the materials being stored in the tank.

### 2.03 METERING SCALE

- A. Provide one 2,000-pound capacity Force Flow Model 40-DR20LP chem-scale, or equal, complete with Force Flow Model Solo G2 indicator, or equal. Indicator shall be 115-volt, single-phase and shall provide a 4-20 mA output proportional to the weight on the scale. Verify scale size with solution tank provided.

### 2.04 FEED PUMPS

- A. Manufacturer
  - 1. Feed units shall be Blue-White Industries, Model AIN10V-6T-0 (16.0 GPD), or equal.
- B. Description:
  - 1. Provide one Blue-White Industries, Model AIN10V-6T-0 (16.0 GPD), chemical feed pumps, or equal. Pumps shall be capable of producing 0.67 gph at 100 psi.

2. Metering pump shall be a positive displacement, peristaltic-type tubing pump with a variable speed motor, non-spring-loaded roller assembly located in the pump head, integral tube failure detection system, and flexible tubing with attached connection fittings.
  - a. There shall be no valves, diaphragms, springs, or dynamic seals in the fluid path. Process fluid shall contact the pump tubing assembly and connection fittings only.
  - b. Pump shall be capable of self-priming at the rated maximum pressure.
  - c. Pump shall be capable of running dry without damage.
  - d. Pump shall provide suction lift of up to 30 feet of water.
3. Metering pump head shall be a single, unbroken track with a clear removable cover.
  - a. Hastelloy C-276 tube failure detection sensors shall be wholly located in the pump head. Tube failure detection system shall not trigger with water contact. Float switch-type switches shall not be used.
  - b. Squeeze rollers shall be directly coupled to a one-piece Valox 420 SEO rotor. Three polymeric squeeze rollers located 120 degrees apart shall be provided. The roller diameters and occlusion gap shall be factory set to provide the optimum tubing compression; field adjustment shall not be required.
  - c. Rotor assembly shall be installed on a D-shaped, chrome-plated motor shaft and removable without tools.
  - d. For tubing installation and removal, rotor assembly shall be rotated by the motor drive. Hand cranking of the rotor assembly shall not be required.
  - e. Pump head and tubing compression surface shall be corrosion resistant Valox 420 SEO thermoplastic.
  - f. The pump head cover shall be clear, acrylic thermoplastic with an integral bearing fitted to support the overhung load on the motor shaft.
  - g. Cover shall be positively secured to the pump head using three thumb screws. Tools shall not be required to remove the pump head cover.
4. Pump tube shall be assembled to connection fittings of PVDF material.
  - a. Connection fittings shall be permanently clamped to the tubing with stainless steel clamps. To prevent tubing misalignment and ensure accuracy, fittings shall insert into keyed slots located in the pump head and secured in place by the pump head cover. Fitting shall not rotate when installed.
  - b. Connection fittings shall accept 1/4-inch i.d. by 3/8-inch o.d. flexible tubing.
5. Pump drive assembly shall be factory installed and totally enclosed in a NEMA 3R, outdoor-rated enclosure.
  - a. Motor shall be DC gear motor-rated for continuous-duty with overload protection. Variable speed motor shall be adjustable from 5 percent to 100% in 1 percent increments. Motor shall continuously rotate over the entire adjustment range; start/stop pulsation shall not be permitted.
  - b. Enclosure material shall be injection molded Valox 420 SEO with NEMA 3R rating. Provide slots in the enclosure base for shelf mounting and two slots in the rear panel for wall mounting. Stainless steel mounting hardware shall be provided.
  - c. Provide 6-foot-length power supply cord with NEMA 5/15 U.S. 115 Vac attachment plug.
  - d. A wiring compartment shall be provided for connection of input/output signal wires, and alarm output load. Conduit hubs, liquid-tight connectors, connector through holes and tapped holes shall be sized in U.S. inches.
6. Control circuitry:
  - a. Provide front panel user touchpad controls for stop/start, configuration menu access and navigation, operating mode selection, auto priming, and service timer reset.
  - b. The front panel touchpad and LCD display shall be wholly enclosed by a clear acrylic door secured by two slide clamps.
  - c. Provide LCD display for menu-driven configuration settings, pump output value, service alerts, and tube failure detection (TFD) system, alarms status, remote input signal values, tubing life timer value.
  - d. Provide for manual control of pump output volume via manual speed percentage operating mode.
  - e. Provide for remote control of pump output volume via 4-20 mA, 0 to 10 Vdc, and 0 to 1000 Hz pulse-operating modes.
  - f. Provide one contact closure alarm output rated at 1A-250 Vac, 0.8A-30 Vdc. Alarm output shall close in the event that the Tube Failure Detection (TFD) system senses a tube failure.



- g. The pump shall be listed to UL standard 778—Motor Operated Pump, CSA Standard C22.2-Process Control Equipment, and NSF/ANSI Standard 61-Drinking Water System Components-Health Effects.
  - h. Tube Failure Detection (TFD) system sensors shall be wholly located in the pump head. TFD system will stop the pump within 3 seconds of leak detection. To prevent false alarms because of rain, washdown, condensation, etc., tube failure detection system shall not trigger with water contact.
7. Spare Parts: Provide two replacement hoses.

## 2.05 ACCESSORIES

- A. Wall Bracket: Provide polyethylene plastic wall shelves for the pumps, large enough for the pumps to mount on. Wall bracket shall be chemically resistant.
- B. Tubing and Fittings: Provide all required tubing and fittings for a complete installation, including injection fittings, main connections, and suction strainers.
- C. Pressure Gauge
  - 1. Quantity: one (1)
  - 2. Range 0-100 PSI
  - 3. Provide with diaphragm seal and isolation ball valve
  - 4. Manufacturers: Plat-O-Matic or equal preapproved by Engineer.
- D. Pressure Relief Valve
  - 1. Furnish and install one (1) pressure relief valve on the metering pump discharge line.
  - 2. Provided by the pump manufacturer and resistant to the chemical being fed.
  - 3. Manufacturer shall size the valve for the feed system.
  - 4. Furnish and install pressure relief tubing and fittings from the pressure relief valve to the tank.
- E. Back Pressure Valve
  - 1. Furnish and install one (1) backpressure valve on the metering pump discharge line.
  - 2. Provided by the pump manufacturer and resistant to the chemical being fed.
  - 3. Manufacturer shall size the valve for the feed system.
- F. Safety Equipment: Provide one (1) set of chemical handling equipment including goggles, apron, and rubber gloves.
- G. Main Line Feed Point (Corporation Stop):
  - 1. Provide 3/4-inch NPT ball valve main connection complete with diffuser.
  - 2. Product: Saf-T-Flo EB-130-B-H or pre-approved equal.
  - 3. Solution tube insertion length shall be such that fluoride is injected into the static mixer at 1/3 diameter of the water pipe.
  - 4. The solution tube tip shall be the manufacturers standard tip configuration.
  - 5. The flexible hose assembly shall be of a material compatible with the chemical being fed and the working pressure in the feed system.

## 2.06 FINISHES

- A. Factory-fabricated items shall have a factory-applied finished paint system.
- B. Other items shall be painted per Division 9.
- C. Plastic solution tank shall not be painted.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Comply with manufacturer's Product Data, including installation instructions and details.
- B. Provide at least 1 day of installation supervision by the manufacturer's representative.

### **3.02 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Services:
  - 1. Inspect and approve the completed installation, make all necessary adjustments, corrections, or modifications prior to start-up.
  - 2. After start-up is authorized by Engineer, furnish a qualified representative to inspect the completed installation, to supervise the system's initial start-up, and to train the operating personnel in operation and equipment maintenance.
  - 3. At least 1 day shall be reserved for start-up and adjustment. See Section 01 75 00.
  - 4. After equipment has been placed into operation, make all final adjustments for the proper operation of the equipment.

### **3.03 WARRANTY**

- A. Standard 1-Year Warranty: Unless otherwise stated below, manufacturer shall warrant the equipment to be free from defects in material and workmanship for a period of 1 year from the earlier of either the date established for partial utilization in accordance with GC14.04 and 14.05, as modified in the Supplementary Conditions, or Substantial Completion of the project.

### **3.04 OPERATOR TRAINING**

- A. Provide a minimum of 4 hours of operator training at Owner's convenience after equipment is operational.
- B. Ensure plant personnel are sufficiently trained and thoroughly acquainted with operations and maintenance materials to operate all components of the system.

**END OF SECTION**

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## SECTION 44 44 73

### FABRICATED PRESSURE FILTER SYSTEM

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Complete vertical pressure system consisting of 16 filter units.
  - 2. Face piping, valves, blowers, and related equipment.
  - 3. Filter valve junction boxes.
  - 4. Installation of equipment.
  - 5. Start-up and testing of the system.
  
- B. Related Sections:
  - 1. Section 09 97 20 - Coating Systems for Industrial Facilities
  - 2. Section 22 15 00 - Compressed Air Systems
  - 3. Section 26 05 00 - Common Work Results for Electrical
  - 4. Section 40 23 00 - Process Piping General Provisions
  - 5. Section 40 23 04 - Process Piping Valves and Operators
  - 6. Section 40 23 10 - Process Water and Waste Piping
  - 7. Section 40 23 40 - Process Piping Hangers and Supports

##### 1.02 REFERENCES

- A. Wisconsin Department of Natural Resources, NR 811.
- B. Recommended Standards for Water Works - Ten State Standards, 2012 Edition.
- C. AWWA B100-09 Granular Filter Material.

##### 1.03 DEFINITIONS

- A. ASTM: American Society for Testing and Materials
- B. AWWA: American Water Works Association
- C. CFM: Cubic feet per minute
- D. GPM: Gallons per minute
- E. MSS: Manufacturers Standardization Society
- F. NSF: National Sanitation Foundation
- G. PPM: Parts per million
- H. SCADA: Supervisory Control and Data Acquisition

##### 1.04 SYSTEM DESCRIPTION

- A. Design Requirements:
  - 1. Design Basis: ATEC Systems Associates, Inc.
  - 2. Contractor shall provide and install sixteen (16) pressure filters, fabricated as shown on the Drawings and as described in these specifications.

3. The filter will be used to treat groundwater pumped from Unit Well 19. Gas chlorine will be added to raw water for oxidation of iron. Backwash wastewater will be discharged to the backwash reclaim tank and recycled to the head of the plant after settling of the solids.
4. Each treatment unit shall be rated for a treatment capacity of 138 GPM, for a total treatment capacity of 2200 gpm.
5. Water only backwash (no air).
6. Design according to Unit Well 19 Pilot Study.
7. Unit Well 19 raw water quality:

Constituent	Unit Well 19
Iron as Fe	0.2 mg/L
Manganese as Mn	45 ug/L
Combined Radium	3.6 pCi/L

### 1.05 SUBMITTALS

- A. Shop Drawings in accordance with Section 01 33 00 and including:
  1. Product data, design drawing, and installation drawings.
  2. Product data on piping, valves, fittings, and other piping and equipment accessories.
  3. Product data and safety data sheets on coatings, abrasives, and coating additives (as applicable).
  4. Coating color chips of available colors.
  5. Backwash rates and duration for water only backwash.
  6. Pressure loss data influent process piping, and effluent process piping.
  7. Confirmation letter that states filter manufacturer has reviewed Owner's functional description. Letter shall include any clarifications and/or revisions (refer to Article 2.07).
  8. Pressure loss data on underdrain system.
- B. Operation and Maintenance Manuals: Prior to start-up, Contractor shall furnish operation and maintenance manual in accordance with Section 01 78 23.
- C. Certification as required by "Source Quality Control."

### 1.06 QUALITY ASSURANCE

- A. Equipment and piping shall be designed and installed to meet WDNR NR 811 regulations.

### 1.07 BASIS OF BID

- A. In order to assure uniform quality, ease of maintenance, and minimal parts storage, it is the intent of the specification that all equipment called for under this section be supplied by a single manufacturer or supplier.
- B. The Base bid shall be based upon the following filter manufacturers, offering products to comply with the specified requirements. The manufacturer shall modify their standard equipment to meet the dimensions, design, and intent of the specifications and Drawings.
  1. ATEC Systems Associates, Inc.
  2. No substitutions.

### 1.08 SEQUENCING

- A. The filter manufacturer shall coordinate the handling and delivery of the treatment unit and associated equipment with the General Contractor, Owner, and Engineer for proper scheduling of construction activities.

## 1.09 WARRANTY

- A. The treatment unit and associated equipment shall be warranted for a period of one year from the date of placing it on-line. Specific warranties for the system include:
1. Treated water effluent warranty:
    - a. The treated water effluent during this period of time for iron and manganese shall not exceed one-half of the secondary maximum contaminant level as established by the US Environmental Protection Agency. Sampling for conformance shall be taken during the middle of a filter run. All adjustments necessary to comply with this warranty shall be made at Contractor's expense.
  2. Backwash waste production warranty:
    - a. The maximum backwash water per filter shall not exceed 30 gpm/ft<sup>2</sup> of filter area. For 16 filters (201 ft<sup>2</sup>), the total backwash volume shall not exceed 42,200 gallons per complete backwash cycle.
    - b. Backwash volume shall be calculated based on a backwash duration of 7 minutes.
  3. Media Loss Warranty
    - a. Less than 1-inch depth from the original installation during the first year of operation. The requirement of 1-inch does not include any media losses due to operation errors by the Utility.
  4. Coating Warranty
    - a. See Section 09 97 20 - Coating Systems for Industrial Facilities, Part 3.09.
- B. All adjustments necessary to comply with these warranties shall be made at the Contractor's expense.

## 1.10 OPERATION AND MAINTENANCE MANUALS

- A. The filter manufacturer shall provide to Owner hardcover bound sets of operation and maintenance instructions in accordance with Section 01 78 23.

## PART 2 PRODUCTS

### 2.01 VERTICAL PRESSURE FILTER VESSELS

- A. General:
1. Quantity: 16.
  2. Each treatment unit shall be rated for a treatment capacity of 138 GPM, for a total treatment capacity of 2,200 gpm.
  3. Diameter: 4'-0".
  4. Maximum filter component height from floor: 14 feet.
  5. Filter Surface Area per Vessel: 12.57 square feet.
  6. Material: Welded Steel Construction
    - a. SA-516 Grade 70 steel.
    - b. Design with safety factor of 3.5.
    - c. Working pressure of 15 to 40 psi.
    - d. Rated for 150 psi.
    - e. Hydrostatic test pressure of 195 psi.
- B. Tank Construction:
1. Tanks shall be of electric welded pressure vessel quality low carbon steel construction rated for 150 psig working pressure and hydrostatically tested at 100 percent in excess of the rated pressure.
  2. Heads shall be built of Grade SA455 steel.
  3. Sidewalls shall be built of Grade SA-572 steel and tank heads and hand-holes shall comply with ASME Code requirements.
  4. Sidewalls shall be at least 1/4-inch nominal gauge and heads shall be at least 1/4-inch nominal gauge.
  5. Tanks shall have stainless steel grooved coupling connections on the service inlet and outlet.
  6. Manifolds shall have a flanged connection on the system inlet and outlet.

7. Access opening for tanks shall include one 11-inch by 15-inch manhole in the top head and one 8-inch circular access port in lower sidewall of the tank as close to lower head as possible to allow for under drain servicing or media removal.
  8. Support for tanks shall be structural steel angle iron legs welded to lower section of the sidewall.
  9. Four filter vessels shall be mounted to a common 4-inch by 6-inch by 1/4-inch tubular steel frame (skid) with forklift brackets and four crane lifting hooks. The skid will be sandblasted and epoxy coated.
  10. This treatment system shall consist of four skids with four each 48-inch diameter filters with 60-inch sidewalls. Filter vessels shall be mounted so that they can be removed individually with the use of standard hand tools and a forklift or similar lifting device.
  11. Gussets with oversized 1-inch bolt holes shall be provided at each inside corner of the skid to allow the system's attachment to the floor by anchor bolts which shall be provided by the Contractor.
  12. Tanks shall be supported on steel saddles and skids of adequate construction to structurally support the tank. Support for tanks shall be structural steel angle iron legs welded to lower section of the sidewall. Structural design of the tanks and tank support system shall be by vessel manufacturer.
- C. Internal Distribution:
1. The filter system shall be a "down-flow" type with untreated water entering the top of the filter and flow through the filter tank and out the bottom of the tank.
  2. The upper distribution system shall be of the baffle type to evenly distribute the water over the entire tank area.
  3. The lower distribution system shall be of a proven design to provide a uniform backwash flow across all of the filter media.
  4. For 48-inch diameter filters, the under drain will be constructed with ten individual stainless steel wedge wire radial outlets with openings of not more than 0.010-inch. The radial arms are secured to a stainless steel hub-base by nipples threaded into stainless steel pipe couplings welded to the hub. Each radial arm shall have adequate outlet orifices for the stated flow located beneath the wedge wire (the specific design requirement is that each arm be capable of handling 37.5 gpm of water with a pressure loss not to exceed 2 psig).
  5. The distribution system shall be embedded in a single layer sub-fill of 3/8-inch by 3/4-inch washed gravel to support the filter bed which is installed at the plant after flow testing.
- D. Backwash System:
1. Backwash system shall be water only, able to allow the system to push water into a backwash reclaim tank lower than the pressure filters.
    - a. All ratings per square foot of filter area.
    - b. Ratings shall be based on actual operating conditions of water temperature and raw water analysis.
- E. Main Operating Valve:
1. The main operating valve on each tank shall be an industrial automatic multi-port diaphragm type, slow opening and closing, free of water hammer.
  2. The diaphragm assembly shall be fully guided on its perimeter when pressure activated from one position to another to assure a smooth reliable shut-off without sticking.
  3. There shall be no contact of dissimilar metals within the valve and no special tools shall be required to service the valve.
  4. The valve shall be actuated pneumatically.
  5. The air pressure to actuate the valve shall be the system pressure plus approximately 5 psig.
  6. The operating valve shall be a Bermad Series 350, 31 4-inch by 4-inch by 4-inch Backwash Valve, the wetted surfaces of which shall be coated with a NSF/ANSI Standard 61 fusion epoxy coating.
- F. Valves:
1. Unless otherwise indicated, all filter and backwash control valves shall be pneumatically actuated.
  2. The pneumatically operated valves shall be operated by solenoid valves. Solenoid valves for control of the filter system and filter backwash sequence shall be assembled in one manifold in one location near each filter skid. Manifold shall be accessible from the floor level. Each solenoid

- valve shall be clearly labeled to identify the process valve being controlled. Solenoid valves shall be Peter Paul Electronics 120VAC and be Model 73, or equal.
3. Butterfly valves on 4-inch filter backwash lines shall be butterfly valves as specified in Section 40 23 20 with air actuators.
  4. Valve and actuator exterior finish shall be factory prepared, minimum SSPC SP10, and primed to 3 to 5 mils D.F.T. in conformance with the requirements of Division 9.
  5. Unless otherwise shown or indicated, all valves shall be butterfly valves as specified in Section 40 23 20.
- G. Valve Junction Boxes:
1. Each 8-pack pressure filter unit shall be equipped with a junction box where all valves cables and wires can be connected to the SCADA in an orderly fashion. SCADA vendor to incorporate the pressure filter valves into the water treatment plant's main SCADA and coordinate the valve operation with the other valves in the water treatment plant. Pressure filter manufacturer shall provide guidance as needed to the SCADA vendor.
- H. Pipe and Fittings:
1. Raw and treated water manifold and piping shall be 6-inch Schedule 40 steel with a nominal wall thickness of 0.25-inch or greater.
  2. Backwash piping shall be Schedule 40 steel unless otherwise specified.
  3. Immersed portions of manifolds shall be coated with a fusion epoxy coating, certified to ANSI/NSF Standard 61 in the same manner specified for filter vessels in Section 2, above except that manifolds with diameters smaller than 3-inch shall be made of Type 316L stainless steel and left uncoated.
  4. A 2-inch threaded connection shall be provided on the inlet manifold for Contractor mounting of an air relief valve.
- I. Flow Control:
1. An adjustable backwash flow restrictor, to assure proper backwashing will be provided by the Contractor.
  2. Backwash flow will be provided internally to the system (i.e. no flow from an auxiliary supply or the distribution system shall be used during backwash).
  3. Proper filter bed fluidization during backwashing shall be required.
  4. Backwash flow rates shall be made at system start-up.
  5. An approved backwash flow meter will monitor backwash flow.
  6. The valves shall be 6-inch Bray Butterfly Valves, Series 20
    - a. Wafer Style.
    - b. Gear Operated.
- J. Air Release Valves:
1. A combination air release and vacuum breaker valve of at least 2-inch size shall be provided for installation into each filter cell or common header.
  2. Air release valves shall be as specified in Section 40 23 20.
- K. Controls:
1. Pressure Filter system shall be controlled from the PLC. System Integrator shall coordinate controls with pressure filter system supplier.
- L. Accessories:
1. Liquid filled pressure gauges of 1/2 percent full scale accuracy in corrosion resistant frames shall be provided.
  2. Pressure gauges shall be 0-100 psig for inlet and outlet manifold of the system.
  3. Gauges shall be 4 1/2 inches in diameter with surge suppression snubbers and will be mounted near the PLC.
  4. Sampling ports will be provided for treated product water from each filter vessel as well as composite sampling ports for raw and finished water and for backwash effluent.
  5. Two 3/4-inch threaded half couplings will be provided, one on the inlet and one on the outlet manifold for such use as the customer may deem appropriate.



6. Provide backwash sight glasses that do not lose transparency with routine plant operation from the materials and sediments in the backwash line.
  - a. On common backwash header
  - b. On the vertical section of the manifold

M. Instructions:

1. Six complete sets of ATEC Systems' Installation, Operating and Maintenance Manual are included with the treatment system.
2. The O&M manual includes schematics of electrical controls.

N. Field Service:

1. The services of a factory authorized service representative shall be made available to supervise, inspect and provide operator training initial start-up and as required for system operation as specified in our bid.

O. Sample Cocks/Instrument Taps:

1. One sample cock shall be located on the influent stream as a composite raw water sampling point.
2. One sample cock shall be located on the effluent stream as a composite treated water sampling point.
3. One sampling cock on the effluent stream of each filter.
4. Sample taps for water shall be constructed of brass, bronze, or stainless steel. They shall be suitable for bacteriological testing and have no internal threads, screens, aerators, external threads at the discharge, or other small areas that would encourage bacterial growth.
5. Ball valve: 1/4-inch.
6. Sample taps for water shall be manufactured by Conbraco, or equal.

## 2.02 PAINTING

A. Surface Preparation:

1. Interior: Sandblast to near white blast cleaning (SSPC-SP10).
2. Exterior: Sandblast to commercial blast cleaning (SSPC-SP6).

B. Coatings:

1. Immersed steel surfaces on tanks of all diameters shall be sand blasted to a near white metal surface finish per SSPC-SP10 finish.
2. Non-immersed steel surfaces shall be Commercial Blast Cleaned as per SSPC-SP6.
3. All filter vessel and manifold immersion service surfaces shall be coated with 3M Company ScotchKote 134, an epoxy fusion coating which conforms to the requirements of ANSI/NSF Standard 61 for contact with potable water and the requirements of AWWA Standards C550 and C213, applied in accordance with the manufacturer's recommendations.
4. Total dry film thickness (DFT) of immersion service coatings shall be at least 10 mils DFT (not to exceed 25 mils DFT to meet ANSI/NSF Standard 61), applied in one or more coats.
5. The exterior finish shall be applied in two coats in accordance with the manufacturer's recommendations.
  - a. Prime Coat - Cardinal 7063 Series Epoxy Primer applied at 2.0-3.0 mils DFT.
  - b. Finish Coat - Cardinal 6400 Series Polyurethane applied at 1.5-2.5 mils DFT.
6. The following colors shall be used in this system:
  - a. Filter and Treated Water Manifolds, True Blue (Cardinal 6407 J02 500-U).
  - b. Raw Water Manifolds, Clover (Cardinal 6407 J02 805-U).
  - c. Backwash Manifolds, Twine (Cardinal 6407 J02 804-U).
  - d. Valves and Fittings, ANSI Gray (Cardinal 6407 GR16-U).

- C. All coating applications shall strictly conform with the manufacturer's recommendations.

## 2.03 FACE PIPING

- A. All piping shall be Schedule 40 seamless or lap welded steel with 150-pound test welded slip-on flanges or ductile iron pipe and fittings unless otherwise specified. All flanges shall be supplied as

shown on the drawings or as necessary to make the assembly easily removable. The face piping shall be constructed of new material.

- B. Face piping and valves shall be supplied by the filter manufacturer to the limits shown on the drawings.
- C. All piping shall be seamless or lap welded steel or grooved steel.
- D. Filter face piping and pneumatic operated valves shall be provided by the filter manufacturer.
- E. Immersed portions of manifolds shall be coated with a fusion epoxy coating, certified to ANSI/NSF Standard 61 in the same manner specified for filter vessels in Section 2.02, above except that manifolds with diameters smaller than 3 inches shall be made of Type 316L stainless steel and left uncoated.
- F. A 2-inch threaded connection shall be provided on the inlet manifold for mounting of an air relief valve by Contractor.

#### **2.04 FILTER MEDIA**

- A. All filter media shall be washed and graded material and meeting the requirements of AWWA B100.
- B. The filter media shall consist of the following:
  - 1. Support Gravel:
    - a. Support gravel shall consist of hard rounded stones and shall not contain more than 2 percent of weight of pieces in which the length is three times the width. The gravel shall be free of shale, mica, clay, sand, dirt, and organic impurities.
    - b. Depth: 4 inches.
    - c. Size: 1/8-inch by 1/4-inch.
    - d. Specific Gravity: not less than 2.5.
    - e. Not more than 25 percent, by weight, of the particles shall have more than one fractured face. Acid solubility shall not exceed 5 percent. Gravel particles shall not be flat or elongated but shall be roughly spherical.
  - 2. Pyrolucite:
    - a. AS 741M Pyrolucite: Pilot testing completed on behalf of Owner determined the filter media shall be pyrolucite-based granular material having both oxidizing and catalytic properties for iron and manganese removal.
    - b. AS 741 Pyrolucite, conforming to this specification, shall be furnished and placed in each filter cell.
      - 1) Depth: 42 inches from the top of the support gravel to the top of the pyrolucite layer after all necessary washing and surface scraping has been completed.
      - 2) Effective size: within the range of 20 to 40 US Mesh.
      - 3) Uniformity Coefficient: not exceeding 1.7.
      - 4) Specific Gravity: minimum 3.5.
    - c. Media shall be a granular material having both oxidizing and catalytic properties for iron and manganese removal.
    - d. Media shall be NSF Certified to ANSI/NSF Standard 61.
    - e. Media shall operate in a pH range of 6.5 to 10.0.
    - f. Iron and manganese shall be removed to the warranty level in Section 1.09.A.1.
    - g. Particle retention shall be ten (10) micron and larger for particles other than iron and manganese.
- C. Regeneration System
  - 1. Gas chlorine is the oxidant that will be used on this system and a system chlorine residual of 2.0 mg/L shall be achieved in the treated water effluent during normal operation.
  - 2. No oxidant other than gas chlorine is authorized for use in this system.

## **2.05 INSTRUMENTATION & CONTROL**

- A. Pressure Gauges:
  - 1. There shall be provided one pressure gauge (0 to 60 psi) on the filter pack inlet and outlet to determine differential pressure across the filter system at all times in the case the PLC is offline. Pressure gauges shall be mounted such that the dial centers are at the same elevation.
- B. Backwash Control Orifice and Rate of Flow Indicator:
  - 1. A stainless steel sharp edged control orifice shall be mounted in the backwash water effluent line. An identification stem shall be attached to the orifice and projected beyond the limits of the orifice flanges. The stem shall indicate the size and direction of the sharp edge.
  - 2. The controller shall be sized to restrict the backwash water flow rate to 28 gpm per square foot.
- C. The pressure filter system and filter backwash shall be controlled by the Programmable Logic Controller (PLC) in the facility SCC. Filter operation and backwash controls are described in Division 26 and shall control automatic functions of the system to include filter function valves; raw water supply; backwash rate; alarms and status conditions; and other functions as required. Contractor shall be responsible for coordinating all necessary controls and programming with filter system supplier and Division 26.
- D. Equipment supplier shall review control description provided by controls contractor. Equipment supplier shall provide written recommendations for additional controls, alarms, and monitoring with shop drawing review.

## **2.06 FABRICATION**

- A. The flanges, plates, angles, channels, and beams shall be joined by continuous full penetration welds on both sides. Each welding pass shall be cleaned by brushing or grinding to remove the welding slag. All finish welds shall be ground so that they are acceptably smooth to receive paint.

## **2.07 SPARE PARTS**

- A. Provide the following spare parts:
  - 1. Five spare solenoid valves for valve actuators.
  - 2. One spare compressor intake air filter.
  - 3. One spare air dryer unit air filter.

## **2.08 ANCHOR BOLTS**

- A. Provide all anchor bolts required for equipment furnished. Anchor bolts shall be of ample strength for the intended service.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Refer to requirements specified in Division 1 for equipment installation, quality control, testing, supervision, start-up, and operator training.
- B. Verify site conditions under provisions of Division 1.
- C. Verify equipment pads, drains and anchor bolts are ready to receive work, and dimensions are as indicated by the shop drawings.
- D. Verify electrical power is available and of correct characteristics.

### **3.02 EQUIPMENT FOUNDATION**

- A. Contractor shall construct concrete foundations for all equipment under this Contract unless noted otherwise. Foundations shall generally be at least 4 inches high, shall consist of six-bag mix concrete, anchor bolts, reinforcing rod dowels into building concrete, and grouting with non-shrink element (containing no iron filings) where required. More specifically, concrete and grout shall meet the requirements found in Division 3.

### **3.03 EXAMINATION**

- A. Existing conditions shall be field verified prior to the fabrication and installation of the filter treatment unit and associated piping and equipment.
- B. Discrepancies discovered before or after work has started shall be immediately brought to the attention of the Engineer. Engineer reserves the right to make minor changes to eliminate such discrepancies at no cost to Owner.
- C. Contractor shall be responsible for unloading and protection of all equipment against damage and during on-site storage and installation. All media must be stored on pallets in a manner that protects it from UV, radiation, and weather.
- D. Contractor shall inspect all material or equipment as it is received to determine damage and/or missing parts. It shall be Contractor's responsibility to repair or replace damaged items in accordance with the manufacturer's instructions.

### **3.04 INSTALLATION OF PRESSURE FILTER EQUIPMENT**

- A. Manufacturer's Services: Contractor shall have the filter manufacturer provide a minimum of 8 working days to inspect and supervise the installation and testing of the pressure filter equipment in 4 trips to the job site.

### **3.05 PERFORMANCE DEMONSTRATION TEST**

- A. Provide manufacturer's services for the following:
  - 1. Start-up for each item of equipment prior to being placed in service.
  - 2. Field testing for each item of equipment prior to being placed in service. Equipment manufacturer shall provide a written report covering checkout, testing, inspections, and startup and shall identify any deficiencies noted. Report shall be submitted to Engineer. Contractor shall be responsible for correcting all deficiencies noted in report. Testing shall comply with the requirements of AWWA B-100, Section 3, and at a minimum shall include: Media Loss Test: Contractor shall guarantee that the filter media loss shall not exceed 1 inch per year provided that backwashing is performed as specified herein. Filter media loss may be determined by measuring average media bed depth at two points in time, one after at least 30 days of operation and the second within 120 days of startup and expressing the difference in inches of media lost per equivalent year of operation. If the equivalent media loss is greater than 1 inch per year, Contractor shall provide an additional supply of media to replace that lost over a 1-year period at no additional cost to Owner.
  - 3. Operator training and final adjustment.
- B. Supervision and Startup: Installation of all equipment furnished under this Contract shall be supervised by a qualified representative of equipment manufacturer. All equipment shall be placed in operation by a qualified representative of the equipment manufacturer, and the plant staff shall be trained to the satisfaction of Owner by a qualified representative of the equipment manufacturer. Owner may videotape training presentations given by manufacturer's representatives. Final payment for various items of equipment will not be made by Owner until the equipment is operating to Owner's satisfaction.
- C. Where items of equipment are placed into service at different times or sequence, manufacturer's services for startup, field testing, and supervision shall be provided for each time or sequence. Training shall be provided prior to or at the time the first similar item of equipment is placed in service.

- D. The equipment manufacturer shall provide the required consecutive 8-hour days of supervisory personnel during installation of the support bed and filter media as well as the necessary consecutive 8-hour days of supervisory personnel for startup of the equipment. The personnel shall make the necessary tests and adjustments to place the equipment into proper operation.
- E. System Supplier shall provide training in operation of the system. The instructions shall include demonstration, assistance and overseeing the backwashing, review of the "Operation and Maintenance Manual," and instructions in the use of auxiliary equipment, etc.
- F. The field supervisor shall provide four complete sets of "Operation and Maintenance Instructions" which shall be bound in hard cover 3-ring binders. The instructions shall define the sequence and timing of the necessary controls, valves, pumps, and meters supplied or controlled by the treatment equipment manufacturer.

### **3.06 DISINFECTION AND MEDIA CHARGING**

- A. After all the potable water process equipment, piping, and filters are completed, they shall be disinfected in accordance with AWWA standards as required by WDNR NR 811.

### **3.07 OPERATOR TRAINING**

- A. The plant's personnel shall be sufficiently trained and thoroughly acquainted with the operation and maintenance manuals to operate all components of the filter system.
- B. The filter manufacturer shall coordinate with the Contractor to determine the amount of training required.

**END OF SECTION**

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