PROJECT MANUAL & SPECIFICATIONS

KETTERING CITY SCHOOLS
LPA PROJECT NO. 93459.00

FOR

ORCHARD PARK ELEMENTARY SCHOOL ADDITION

MAY 2019

PREPARED BY

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SHOOK TOUCHSTONE
# PROJECT MANUAL & SPECIFICATIONS

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March 14, 2019

Kettering City School District
c/o Levin Porter Associates
3011 Newmark Dr.
Miami, Ohio 45342

Attn: Mr. Mark Wiseman

Re: Geotechnical Engineering Investigation for the Proposed Additions to Orchard Park and Southdale Elementary Schools in Kettering, Ohio; CBC Report No. 22185D-1-0319-02

Mr. Wiseman:

We are pleased to submit our report of the geotechnical engineering investigation for the above-referenced project. The purpose of this study is to provide an evaluation of the physical characteristics of the soil strata and net allowable bearing capacities at the locations tested. Also noted are other conditions that might affect the design and/or construction of the proposed additions to Orchard Park and Southdale elementary schools in Kettering, Ohio based on the results of the testing.

For your convenience, the samples collected that were not used to perform the laboratory tests will be kept in our office for a period of three months. If you have any questions, or if we can be of further service, please call us.

Respectfully submitted,

CBC Engineers & Associates, Ltd.

[Signature]
Deepa Nair, M.S., P.E.
Project Engineer

[Signature]
Mitchell T. Hardert, P.E.
Chief Engineer

DN/MTH/rh

c: Client (mwiseman@levin-porter.com)

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SECTION I

TEXT
1.0 INTRODUCTION

Authorization to proceed with this investigation was given by Kettering City Schools in PO #19002876. Work was to proceed in accordance with CBC Engineers & Associates, Ltd. Quotation No. 19-041-02, dated January 31, 2019, and the terms and conditions of the contract attached thereto.

The proposed additions are to be located at Orchard Park and Southdale elementary schools in Kettering, Ohio. A Vicinity Map is presented in Figure 1 in Section III of this document.

2.0 WORK PERFORMED

2.1 FIELD WORK

Two (2) borings (CBC-1 and CBC-2) were made in the relative positions at the Orchard Park elementary school site as shown on the Boring Location Plan (Figure 2) in Section III. Two (2) borings (CBC-3 and CBC-4) were also made in the relative positions at the Southdale elementary school site as shown on the Boring Location Plan (Figure 2A) in Section III. The boring logs and resulting data are also included in Section III. The borings were made with an ATV mounted drilling rig using hollow-stem augers and employing standard penetration resistance methods (ASTM D-1586, which includes 140-pound hammer, 30-inch drop, and two-inch-O.D. split-spoon sampler) at maximum 2.5 foot intervals for 10 feet below the ground surface and at 5 foot intervals to the bottom of the borings. The disturbed split-spoon samples were visually classified, logged, sealed in moisture-proof jars, and taken to the CBC Engineers & Associates, Ltd. laboratory for study. The depths where these "A"-type split-spoon samples were collected are noted on the boring logs.

2.2 LABORATORY WORK

Sixteen (16) natural moisture content determinations were made in accordance with ASTM D-4643. The results of these tests are tabulated in Table 1 as follows, and are also included in Section III of this report:
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RESULTS OF NATURAL MOISTURE CONTENT TESTS (ASTM D-4643)

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<th>BORING NO.</th>
<th>DEPTH INCREMENT, (FT.)</th>
<th>NATURAL MOISTURE CONTENT, %</th>
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<td>CBC-1</td>
<td>3.5 – 5.0</td>
<td>12.4</td>
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<tr>
<td>CBC-1</td>
<td>6.0 – 7.5</td>
<td>12.3</td>
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<td>3.5 – 5.0</td>
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<td>1.0 – 2.5</td>
<td>9.6</td>
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3.0 SOIL CONDITIONS AND GROUNDWATER LEVELS

Two (2) borings (CBC-1 and CBC-2) were made in the relative positions at the Orchard Park elementary school site as shown on the Boring Location Plan (Figure 2) in Section III. Boring CBC-1 was made on an existing asphalt pavement consisting of approximately 6 inches of asphalt layer overlying gravel base layer of approximate thickness of 4 inches. The proposed development site was generally overlain in boring CBC-2 by topsoil of approximate thickness of 6 inches. Medium stiff clayey soils were encountered in the borings underneath the topsoil/asphalt pavement with SPT blow counts varying from 5 to 23 as shown on the boring logs. This cohesive stratum extended to the bottom of boring CBC-1. Highly weathered sandstone rock was encountered in boring CBC-2 at an approximate depth of 7.0 feet below the existing site grade. Auger Refusal on rock (apparent boulder or bedrock) was encountered at an approximate depth of 7.5 feet below the existing site grade in boring CBC-2.

Two (2) borings (CBC-3 and CBC-4) were made in the relative positions at the Southdale
elementary school site as shown on the Boring Location Plan (Figure 2A) in Section III. Borings CBC-3 and CBC-4 were made on an existing asphalt pavement consisting of approximately 3 to 4 inches of asphalt layer overlying gravel base layer of approximate thickness varying from 5 to 6 inches. Medium stiff clayey/silty soils were encountered in the borings underneath the asphalt pavement with SPT blow counts generally varying from 6 to 31 as shown on the boring logs. This cohesive stratum extended to the bottom of boring in boring CBC-4. Medium dense sand and gravel was encountered underneath the cohesive stratum at an approximate depth of 9.0 feet in boring CBC-3. SPT blow counts in the sand and gravel varied from 30 to 37. Very soft clay with relatively higher water content was encountered at an approximate depth of 6.0 feet (approximate thickness of 2.5 feet) in the area of boring CBC-4 with SPT blow counts as low as 2.

Groundwater observations were made during the drilling operations (by noting the depth of water on the drilling tools) and in the open boreholes following withdrawal of the drilling augers. Free groundwater was encountered at the time of drilling activities in the borings at the depths tabulated in Table 2 as follows at the time of drilling activities:

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>DEPTH TO GROUNDWATER DURING DRILLING ACTIVITIES (FT)</th>
<th>DEPTH TO GROUNDWATER AT THE COMPLETION OF DRILLING ACTIVITIES (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC-1</td>
<td>14.0</td>
<td>14.0</td>
</tr>
<tr>
<td>CBC-2</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>CBC-3</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>CBC-4</td>
<td>Dry</td>
<td>Dry</td>
</tr>
</tbody>
</table>

However, it should be noted that short-term water level readings are not necessarily a reliable indication of the groundwater level and that significant fluctuations may occur due to variations in rainfall and other factors. For specific information on the soil conditions, please refer to the individual boring logs in Section III.
Based on the encountered soil conditions at the project site, the site classification was determined to be "Site Class D" per the Ohio Building Code. In addition, a $S_{DS}$ coefficient of 0.161g was calculated, and a $S_{D1}$ coefficient of 0.115g was also calculated for design based on the aforementioned building code. A "Site Class D" suggests that the soil materials are stiff with standard penetration test "N-values" between 15 and 50.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 PROJECT DESCRIPTION

Kettering City Schools and Levin Porter Associates are currently developing information regarding proposed additions to the Orchard Park and Southdale elementary schools in Kettering, Ohio. No details of the proposed project regarding the structural loads of the proposed facilities have been provided to us at this time. The following recommendations are based on the assumption that no unusual loading conditions or special settlement restrictions apply to the proposed project and the foundations for the future construction are proposed to be shallow foundations. Consequently, if the above information is incorrect or if changes are made, CBC Engineers & Associates, Ltd should be notified so that the new data can be reviewed.

4.2 BUILDING AREA

4.2.1 ORCHARD PARK ELEMENTARY SCHOOL SITE

All topsoil or other deleterious materials should be stripped from the entire footprint of the proposed building area. Subsequently, the top foot of the stripped ground surface should be compacted to at least 95% of the maximum dry unit weight as determined by ASTM D-1557 (modified Proctor). This compacted bearing surface should be observed and tested by a representative of this office before any footing addition/engineered fill placement. Once the building pad is prepared according to these recommendations, spread-footing foundations can be placed on the new engineered fill, or on the original clayey soils. The spread footing elements bearing on these materials can be designed for an allowable bearing capacity of 1,000 psf. This net allowable bearing pressure can be increased by a factor of one-third when designing for transient loadings such as wind or earthquake ground motions. All foundations should bear at a
depth of at least 32 inches below the final grade for frost heave considerations. Square and continuous footings for the structures should be designed at least 2.5 feet and 1.5 feet wide, respectively, even if the anticipated structure loadings would allow for smaller foundation element sizes. It is recommended that CBC Engineers be retained to confirm the acceptability of the bearing soils and verify the recommended bearing capacities once the excavation is completed before the footings are poured.

4.2.2 SOUTHDALE ELEMENTARY SCHOOL

All topsoil or other deleterious materials should be stripped from the entire footprint of the proposed building area. Subsequently, the top foot of the stripped ground surface should be compacted to at least 95% of the maximum dry unit weight as determined by ASTM D-1557 (modified Proctor). This compacted bearing surface should be observed and tested by a representative of this office before any footing addition/engineered fill placement. The native medium stiff clayey soils encountered at the project site are suitable for foundation support. Very soft clayey soils were encountered at an approximate depth of 6.0 feet (approximate thickness of 2.5 feet) in the area of boring CBC-4. Therefore, the existing soft soils encountered underneath the footings in the area of boring CBC-4 should be undercut excavated to an approximate depth of 8.5 feet below the existing grade until stiffer material is reached, and the excavation backfilled to the bottom of the foundations using engineered fill compacted to at least 95% of the maximum dry unit weight with a moisture content within 2% of the optimum moisture content as determined by the modified Proctor test, or with lean concrete. In order to ensure the presence of suitable bearing soil at the bottom of the foundation excavation, the bottom of the excavation should be observed and tested by a representative of this office. All exposed subgrade at the bottom of the foundation excavations should be compacted to at least 95% of the maximum dry unit weight with a moisture content within 2% of the optimum moisture content as determined by modified Proctor test before engineered fill/footing placement. Once the building pad is prepared according to these recommendations, spread-footing foundations can be placed on the new engineered fill, or on the original clayey soils. The spread footing elements bearing on these materials can be designed for an allowable bearing capacity of 1,000 psf. This net allowable bearing pressure can be increased by a factor of one-third when
designing for transient loadings such as wind or earthquake ground motions. All foundations should bear at a depth of at least 32 inches below the final grade for frost heave considerations. Square and continuous footings for the structures should be designed at least 2.5 feet and 1.5 feet wide, respectively, even if the anticipated structure loadings would allow for smaller foundation element sizes. It is recommended that CBC Engineers be retained to confirm the acceptability of the bearing soils at the recommended depths and verify the recommended bearing capacities once the excavation is completed before the footings are poured.

4.2.3 ENGINEERED FILL AND COMPACTION REQUIREMENTS

Engineered fill placed at the project site should be compacted to at least 95% of the maximum dry unit weight with moisture content within 2% of the optimum moisture content as determined by the modified Proctor test. Excavated material that is free of organic or objectionable materials can be reused as fill. In general, any non-organic naturally-occurring soils can be used for structural fill. Cohesive soils with Liquid Limit (LL) greater than 50, a Plastic Index (PI) of greater than 25, or an organic content greater than 7 percent as determined by Loss-on-Ignition (ASTM D2974) should not be used for engineered fill. The fill should contain no fragments whose greatest dimension is larger than half the thickness of the lift being placed. The existing native soils appear to be suitable for reuse as engineered fill but will require moisture adjustments and possible screening for deleterious content.

All soil bearing foundations settle as the result of the externally applied loads. Settlement of proposed foundations designed to the recommendation provided herein should be anticipated, although such movements are estimated (based upon our experience in similar soils) to be within the tolerable limits for conventional structures (i.e., the total settlement will be less than about 1 inch, while differential settlement will be limited to about one half of this value).

Backfill for utility trenches, foundation excavations, etc., within structures, driveways, or parking lot areas should be placed in successive, horizontal layers. Each layer should be compacted to 95% of the maximum modified Proctor dry unit weight within 2% of the optimum moisture content before the next layer is added. In no instance should puddling or jetting the
backfill material be allowed as a compaction method. Any silty or clayey soils at foundation depth will soften and the bearing capacity will be reduced if water ponds in the excavation. Soils exposed in the bases of all satisfactory foundation excavations should be protected against any detrimental change in condition such as from disturbance, rain and freezing. Surface run-off water should be drained away from the excavation and not allowed to pond. If possible, all foundation concrete should be placed the same day the excavation is made. If this is not practical, the foundation excavations should be adequately protected. Also, for this reason, proper drainage should be maintained after construction.

All foundations should be located so that the least lateral clear distance between any two foundations will be at least equal to the difference in their bearing elevations (see Figure 3 in Section III of this document). If this distance cannot be maintained, the lower foundation should be designed to account for the load imparted by the upper foundation. If this condition occurs adjacent to a below-grade wall, the wall should be designed for the additional lateral earth pressure due to the upper foundation.

4.2.4 LATERAL AND UPLIFT FORCES ON SHALLOW FOOTINGS

Lateral forces on the foundation elements can be resisted by passive lateral earth pressures against the opposite vertical face of the foundation and by friction along the soil/foundation interface. An allowable resisting passive earth pressure of 200 lbs./sq. ft., and coefficient of friction of 0.35, respectively, can be used for design purposes. The passive resistance should only be used for that portion of the foundation located at a depth greater than 2.5 feet beneath the final grade (Please see Figure 4 in Section III of this text). A factor of safety of 1.5 relative to the lateral capacity should be used in design. It should be noted that lateral movements, on the order of up to 0.5 inch, may occur to mobilize this lateral resisting force.

It is further recommended that only the weight of the footing and the total weight of the soil above and within the periphery of the footing be used for resisting uplift forces. A total soil unit weight of 120 lbs./cu. ft. should be used for these computations for backfill material compacted as recommended in Section 4.2 (Please see Figure 5 in Section III of this document).
It is also recommended that a factor of safety of at least 1.5 be used in calculating uplift resistance due to the weight of the footing and the backfill soil.

### 4.2.5 LATERAL EARTH PRESSURES ON BELOW GRADE WALLS

The magnitude of lateral earth pressure against subsurface walls is dependent on the method of backfill placement, the type of backfill soil, drainage provisions and whether or not the wall is permitted to yield during and/or after placement of the backfill. When a wall is held rigidly against horizontal movement, the lateral pressure against the wall is greater than the "active" earth pressure that is typically used in the design of free-standing retaining walls. Therefore, rigid walls should be designed for higher, "at-rest" pressures (using an at-rest lateral earth pressure coefficient, $K_o$), while yielding walls can be designed for active pressures (using an active lateral earth pressure coefficient, $K_a$).

For use in these computations, a total soil unit weight of 130 lbs/cu. ft. should be used. For below-grade walls, a coefficient of earth pressure at-rest ($K_o$) of 0.5 and a coefficient of "active" earth pressure of 0.33 are recommended, provided a well-graded granular material is used for backfill (Please see Figure 6 in Section III of this document). Also, a passive earth pressure coefficient of 2.75 should be used in design. The granular backfill material should extend upward and outward from the base of the wall on a slope not steeper than about 1 (horizontal) to 1 (vertical). This method of computation presumes that there will be no hydrostatic pressure due to water build-up.

It is recommended that the static weight per axle of equipment utilized for the compaction of the backfill materials not exceed 2 tons per axle for non-vibratory equipment and 1 ton per axle for vibratory equipment. All heavy equipment, including compaction equipment heavier than recommended above, should not be allowed closer to the wall (horizontal distance) than the vertical distance from the backfill surface to the bottom of the wall. If it is desired to use heavier compaction equipment adjacent to the below grade wall, it is recommended that this office be contacted to determine the resulting earth pressures.
4.2.6 SLABS-ON-GRADE

The topsoil or any other deleterious softer soil below any proposed floor slab should be excavated until all deleterious topsoil/softer material is completely removed, and the excavation backfilled to the bottom of the floor slab with compacted engineered fill. The exposed sub-grade at the base of the slabs-on-grade must be recompacted to at least 95% of the maximum dry unit weight within 2% of the optimum moisture content as determined by the modified Proctor test. Slabs-on-grade can then be supported on new compacted structural fill or native soils.

It is recommended that all slabs-on-grade be "floating", that is, fully ground supported and not structurally connected to walls or foundations. This is to minimize the possibility of cracking and displacement of the slabs-on-grade because of differential movements between the slab and the foundation. Although the movements are estimated to be within the tolerable limits for structural safety, such movements could be detrimental to the slabs if they were rigidly connected to the foundations.

It is furthermore recommended that the slabs-on-grade be supported on a 4 to 6-inch layer of relatively clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and equalize moisture conditions beneath the slab. Proper drainage must be incorporated into this granular layer to preclude future wet areas in the finished slab-on-grade. However, all deleterious materials encountered during site preparation must be removed and replaced with select engineered fill that is compacted to the specifications previously outlined in Section 4.2 of this report. Provided that a minimum of 4 inches of granular material is placed below the new slab-on-grade, a modulus of subgrade reaction (k30) of 100 lbs./cu. in. can be used for design of the slabs.

4.2.7 FOUNDATION EXCAVATIONS

Each foundation excavation should be inspected to insure that all loose, soft or otherwise undesirable material is removed and that the foundation will bear on satisfactory material.

If pockets of soft, loose or otherwise unsuitable material are encountered in the footing excavations and it is inconvenient to lower the footings, the proposed footing elevations may be
re-established by backfilling after the undesirable material has been removed. The undercut excavation beneath each footing should extend to suitable bearing soils and the dimensions of the excavation base should be determined by imaginary planes extending outward and down on a 1 (vertical) to 1 (horizontal) slope from the base perimeter of the footing as illustrated in Figure 7 in Section III. The entire excavation should then be refilled with a well-compacted engineered fill, or lean concrete (please note that the width of the lean concrete zone should be equal to or wider than the width of the overlying footing element). Special care should be exercised to remove any sloughed, loose or soft materials near the base of the excavation slopes. All Federal, State, and Local regulations should be strictly adhered to relative to excavation side-slope geometry.

5.0 SLOPE CONSIDERATIONS

A detailed slope stability analysis is beyond the scope of this study. However, it is recommended that fill slopes less than 10 feet in height be designed for slopes not steeper than 2.5 (horizontal) to 1 (vertical). For any fill greater than 10 feet in height, it is recommended that slopes be not steeper than 3 (horizontal) to 1 (vertical).

In general, temporary cut slopes of 2 (horizontal) to 1 (vertical) should remain stable during a reasonable construction period provided they are not higher than about 10 feet and are not subjected to excessive vibration from construction equipment and are protected from surface erosion. The need for temporary bracing of utility trenches should be anticipated. In general, any permanent cut slopes should be no steeper than about 3 (horizontal) to 1 (vertical).

6.0 CONSTRUCTION Dewatering

At the time of our investigation, free groundwater level was encountered at relatively shallow depths (approximately 4.0 feet below existing site grade) at the Orchard Park elementary school site. No free groundwater was encountered at the time of our investigation at the Southdale elementary school site. However, significant quantities of groundwater should be anticipated in the proposed excavations at both sites due to the presence of sand and gravel zones. In order to maintain proper bearing support for the foundations, the entire excavation area must be dewatered (groundwater level lowered) to at least 2 feet below the deepest excavation
elevation prior to the placement of engineered fill, and the dewatering of the area maintained until the foundations are fully constructed. Sump pumping is generally a suitable method of dewatering in such areas where the required depth of groundwater to be lowered is generally less. Extra care must be exercised when pumping from sumps that extend into silts and other granular soils as observed at this site, as a general deterioration of the bearing soils and a localized "quick" condition could result. Extra care must also be exercised during pumping to ensure that the loss of fines does not occur and filter fabric should be used as necessary to maintain a soil-tight system. It is imperative that the dewatering of the excavations and subgrade soils be continually maintained until the engineered fill and foundations are fully constructed, and they are providing confinement of the underlying soils. If the groundwater level is allowed to rise to the surface of the excavation areas without the surface being confined, detrimental softening and degradation of the engineered fill and subgrade soils should be expected that will require remedial measures in order to provide adequate support for the structure. The evaluation and design of any required temporary or permanent dewatering measures to facilitate proper construction and proper in-service conditions is the responsibility of others than CBC Engineers & Associates, Ltd.

7.0 SITE PREPARATION

All areas that will support foundations and slabs-on-grade should be properly prepared. After rough grade has been established in cut areas and prior to placement of fill in all fill areas, the exposed subgrade should be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft or loose soil, and other undesirable existing materials should be removed and replaced with engineered fill. Aeration of the near-surface in-situ soils should be anticipated prior to their placement as engineered fill (or lime stabilization can also be used). The exposed subgrade should furthermore be inspected by proofrolling with a loaded tandem axle truck or other suitable equipment to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed should be removed and replaced with well-compacted, engineered fill as outlined in the specifications of this document. However, it may also become necessary (due to the presence of soft exposed soil materials) to employ lime stabilization or to locally incorporate ODOT No. 2 aggregate into the subgrade to increase its stiffness.
In general, care should be exercised during the grading operations at the site. Due to the nature of the near surface soils, the traffic of heavy equipment, including heavy compaction equipment, may create pumping and general deterioration of the shallower soils, especially if excess surface water is present. If this occurs, it may be necessary to utilize a biaxial/triaxial geogrid, lime stabilization, or other methodology (such as the incorporation of ODOT No. 2 aggregate into the subgrade) to stabilize the disturbed subgrade. The grading, therefore, should be done during a dry season, if at all possible.

In addition, it must be emphasized that once engineered fill is properly placed on the project site, that these materials can also degrade significantly due to the effects of heavy construction traffic and wet weather. This degradation may in some cases require the excavation and replacement of the engineered fill with aerated, lime-stabilized fill materials; hence, caution should be exercised to avoid such degradation of these soil materials.

It should be noted that when vibratory rollers are utilized on certain soils types (such as fine grain sands or silts), that shear induced pore water pressures may be developed within these materials which will result in significant "pumping" of these materials (even though these soils may be stiff and pass moisture density tests on engineered fills). Therefore (in these types of soils), it is imperative that the vibrator not be utilized and that these soils be statically rolled in order to preclude the development of such shear induced pore water pressures. These shear induced pore water pressures dissipate over a number of days (depending on the permeability of the soil materials); however, in the short term, significant "pumping" of these materials can be witnessed in the field.

8.0 SOIL SWELLING POTENTIAL

Based upon the laboratory tests performed for this study and the mineralogy of typical soils from the general vicinity of the project site, no significant soil swelling is anticipated. To our knowledge, there are no instances of problems associated with soil swelling in the project vicinity.
9.0 LIQUEFACTION

When certain soils (generally only granular soils) below the groundwater table are subjected to dynamic loads, such as those produced by earthquakes, a sudden increase in pore water pressure occurs as the result of shearing of the soil particles past one another. In extreme cases, when these shear induced pore water pressures exceed the strength of the soil, the soil strength can reduce to zero thereby resulting in a phenomenon known as "liquefaction." Conditions at this site have been examined to determine the likelihood for liquefaction of the natural soils during earthquake ground motions.

Soil type, relative density, initial confining pressure (i.e., the depth of the potentially liquefiable soil below the ground surface) and the magnitude of potential ground motions are the most important factors in determining the liquefaction potential of a soil mass. It is generally agreed that saturated, relatively loose (with blow counts or "N" values typically less than about 13) in the upper 50 feet or so are most susceptible to liquefaction.

Clayey soils are generally considered to be non-vulnerable to liquefaction. It is, therefore, concluded that liquefaction (or any significant loss of strength) of the soils underlying the project site during earthquake ground motions is extremely unlikely. To our knowledge, there are no recorded cases of liquefaction of subsurface materials similar to those at this project site. Therefore, no special design measures relative to soil liquefaction appear to be warranted.

10.0 BURIED UTILITY PIPES

Excavations for buried utility pipelines should follow the guidelines set forth previously in this report. Depending on the pipeline material, a minimum thickness of at least 0.5 foot of select fine-grained granular bedding material should be used beneath all below-grade pipes, with a minimum cover thickness of at least 3 feet to afford an "arching" effect and reduce stresses on the pipe. The cover thickness may be reduced if the external loading condition on the pipe is relatively light or if the pipe is designed to withstand the external loading condition. It is not recommended that "pea-gravel" or other "open-work" aggregates be used for trench backfill since these materials are nearly impossible to compact and have a tendency to pond water within their interstices.
11.0 **DRAINAGE**

Adequate drainage should be provided at the site to minimize any increase in moisture content of the foundation soils. The exterior grade (including all parking areas) should be sloped away from all facility structures to prevent ponding of water.

12.0 **CLOSURE**

12.1 **BASIS OF RECOMMENDATIONS**

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions. Data used during this exploration included, but were not necessarily limited to:

- Four (4) exploratory borings performed during this study,
- observations of the project site by our staff,
- results of the laboratory soil tests,
- site plans and drawings furnished by Levin Porter Associates,
- supportive interaction with Levin Porter Associates; and
- published soil or geologic data of this area.

In the event that changes in the project characteristics are planned, or if additional information or differences from the conditions anticipated in this report become apparent, CBC Engineers & Associates, Ltd., should be notified so that the conclusions and recommendations contained in this report can be reviewed and, if necessary, modified or verified in writing.

12.2 **LIMITATIONS OF STUDY/RECOMMENDED ADDITIONAL SERVICES**

The subsurface conditions discussed in this report and those shown on the boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual test borings
are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by designers, or that the construction process has altered the soil conditions. As variations in the soil profile are encountered, additional subsurface sampling and testing may be necessary to provide data required to re-evaluate the recommendations of this report. Consequently, after submission of this report it is recommended that CBC Engineers & Associates, Ltd. be authorized to perform additional services to work with the designer(s) to minimize errors and omissions regarding the interpretation and implementation of this report.

Prior to construction, we recommend that CBC Engineers & Associates, Ltd.:

- work with the designers to implement the recommended geotechnical design parameters into plans and specifications,
- consult with the design team regarding interpretation of this report,
- establish criteria for the construction observation and testing for the soil conditions encountered at this site; and
- review final plans and specifications pertaining to geotechnical aspects of design.

During construction, we recommend that CBC Engineers & Associates, Ltd.:

- observe the construction, particularly the site preparation, fill placement, and foundation excavation or installation,
- perform in-place density testing of all compacted fill,
- perform materials testing of soil and other materials as required; and
- consult with the design team to make design changes in the event that differing subsurface conditions are encountered.

If CBC Engineers & Associates, Ltd. is not retained for these services, we shall assume no responsibility for construction compliance with the design concepts, specifications or recommendations.
12.3 WARRANTY

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made.

While the services of CBC Engineers & Associates, Ltd. are a valuable and integral part of the design and construction teams, we do not warrant, guarantee, or insure the quality or completeness of services provided by other members of those teams, the quality, completeness, or satisfactory performance of construction plans and specifications which we have not prepared, nor the ultimate performance of building site materials.

12.3.1 SUBSURFACE EXPLORATION

Subsurface exploration is normally accomplished by test borings, although test pits are sometimes employed. The method of determining the boring location and the surface elevation at the boring is noted in the report, and is presented on the Boring Location Plan or on the boring log. The location and elevation of the boring should be considered accurate only to the degree inherent with the method used.

The boring log includes sampling information, description of the materials recovered, approximate depth of boundaries between soil and rock strata and groundwater data. The boring log represents conditions specifically at the location and time the boring was made. The boundaries between different soil strata are indicated at specific depths; however, these depths are in fact approximate and are somewhat dependent upon the frequency of sampling (The transition between soil strata is often gradual). Free groundwater level readings are made at the times and under conditions stated on the boring logs (Groundwater levels change with time and season). The borehole does not always remain open sufficiently long enough for the measured water level to coincide with the groundwater table.

12.3.2 LABORATORY AND FIELD TESTS

Laboratory and field tests are performed in accordance with specific ASTM standards unless otherwise indicated. All determinations included in a given ASTM standard are not
always required and performed. Each test report indicates the measurements and determinations actually made.

12.3.3 ANALYSIS AND RECOMMENDATIONS

The geotechnical report is prepared primarily to aid in the engineering design of site work and structural foundations. Although the information in the report is expected to be sufficient for these purposes, it is not intended to determine the cost of construction or to stand alone as a construction specification.

Our engineering report recommendations are based primarily on data from test borings made at the locations shown on a boring location plan included in this report. Soil variations may exist between borings and these variations may not become evident until construction. If significant variations are then noted, the geotechnical engineer should be contacted so that field conditions can be examined and recommendations revised if necessary.

The geotechnical engineering report states our understanding as to the location, dimensions and structural features proposed for the site. Any significant changes in the nature, design, or location of the site improvements MUST be communicated to the geotechnical engineer such that the geotechnical analysis, conclusions, and recommendations can be appropriately adjusted. The geotechnical engineer should be given the opportunity to review all drawings that have been prepared based on their recommendations.

12.3.4 CONSTRUCTION MONITORING

Construction monitoring is a vital element of complete geotechnical services. The field engineer/inspector is the owner's "representative" observing the work of the contractor, performing tests as required in the specifications, and reporting data developed from such tests and observations. The field engineer or inspector does not direct the contractor's construction means, methods, operations or personnel. The field inspector/engineer does not interfere with the relationship between the owner and the contractor and, except as an observer, does not become a substitute owner on site. The field inspector/engineer is responsible for his own safety but has no responsibility for the safety of other personnel at the site. The field inspector/engineer
is an important member of a team whose responsibility is to watch and test the work being done and report to the owner whether that work is being carried out in general conformance with the plans and specifications.

12.3.5 GENERAL

The scope of our services did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, within or beyond the site studied. Any statements in the report or on the boring logs regarding odors, staining of soils or other unusual items or conditions observed are strictly for the information of our client.

To evaluate the site for possible environmental liabilities, we recommend an environmental assessment, consisting of a detailed site reconnaissance, a record review, and report of findings. Additional subsurface drilling and samplings, including groundwater sampling, may be required. CBC Engineers & Associates, Ltd. can provide this service and would be pleased to provide a cost proposal to perform such a study, if requested.

This report has been prepared for the exclusive use of Kettering City Schools and Levin Porter Associates, for specific application to the proposed additions to the Orchard Park and Southdale elementary schools (see Figure 1 in Section III of this report). Specific design and construction recommendations have been provided in the various sections of the report. The report shall, therefore, be used in its entirety. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw their own conclusions regarding specific construction techniques and methods chosen. CBC Engineers & Associates, Ltd. is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploratory and laboratory test data presented in this report.
SECTION II

SPECIFICATIONS
I - ENGINEERED FILL BENEATH STRUCTURES

CLEARING AND GRADING SPECIFICATIONS

1.0 GENERAL CONDITIONS

The Contractor shall furnish all labor, materials, and equipment, and perform all work and services necessary to complete in a satisfactory manner the site preparation, excavation, filling, compaction and grading as shown on the plans and as described therein.

This work shall consist of all clearing and grading, removal of existing structures unless otherwise stated, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades, slopes, and specifications.

This work is to be accomplished under the constant and continuous supervision of the Owner or his designated representative.

In these specifications the terms "approved" and "as directed" shall refer to directions to the Contractor from the Owner or his designated representative.

2.0 SUBSURFACE CONDITIONS

Prior to bidding the work, the Contractor shall examine, investigate and inspect the construction site as to the nature and location of the work, and the general and local conditions at the construction site, including without limitation, the character of surface or subsurface conditions and obstacles to be encountered on and around the construction site; and shall make such additional investigation as he may deem necessary for the planning and proper execution of the work. Borings and/or soil investigations shall have been made. Results of these borings and studies will be made available by the Owner to the Contractor upon his request, but the Owner is not responsible for any interpretations or conclusions with respect thereto made by the Contractor on the basis of such information, and the Owner further has no responsibility for the accuracy of the borings and the soil investigations.

If conditions other than those indicated are discovered by the Contractor, the Owner should be notified immediately. The material which the Contractor believes to be a changed condition should not be disturbed so that the Owner can investigate the condition.

3.0 SITE PREPARATION

Within the specified areas, all trees, brush, stumps, logs, tree roots, and structures scheduled for demolition shall be removed and disposed of.

All cut and fill areas shall be properly stripped. Topsoil will be removed to its full depth and stockpiled for use in finish grading. Any rubbish, organic and other objectionable soils, and
other deleterious material shall be disposed of off the site, or as directed by the Owner or his
designated representative if on site disposal is provided. In no case shall such objectionable
material be allowed in or under the fill unless specifically authorized in writing.

Prior to the addition of fill, the original ground shall be compacted to job specifications as
outlined below. Special notice shall be given to the proposed fill area at this time. If wet spots,
spongy conditions, or groundwater seepage is found, corrective measures must be taken before
the placement of fill.

4.0 FORMATION OF FILL AREAS

Fills shall be formed of satisfactory materials placed in successive horizontal layers of
not more than eight (8) inches in loose depth for the full width of the cross-section. The depth of
lift may be increased if the Contractor can demonstrate the ability to compact a larger lift. If
compaction is accomplished using hand-tamping equipment, lifts will be limited to 4-inch loose
lifts. Engineered fill placed shall be compacted to at least 95% of the maximum dry unit weight
with a moisture content within 2% of the optimum moisture content as determined by the
modified Proctor test.

All material entering the fill shall be free of organic matter such as leaves, grass, roots,
and other objectionable material.

The operations on earth work shall be suspended at any time when satisfactory results
cannot be obtained because of rain, freezing weather, or other unsatisfactory conditions. The
Contractor shall keep the work areas graded to provide the drainage at all times.

The fill material shall be of the proper moisture content before compaction efforts are
started. Wetting or drying of the material and manipulation to secure a uniform moisture content
throughout the layer shall be required. Should the material be too wet to permit proper
compaction or rolling, all work thus affected shall be delayed until the material has dried to the
required moisture content. The moisture content of the fill material should be no more than two
(2) percentage points higher or lower than optimum unless otherwise authorized. Sprinkling
shall be done with equipment that will satisfactorily distribute the water over the dissected area.
Any areas inaccessible to a roller shall be consolidated and compacted by mechanical tampers.
The equipment shall be operated in such a manner that hardpan, cemented gravel, clay or other
chunky soil material will be broken up into small particles and become incorporated with the
other material in the layer. The fill shall contain no fragments whose greatest dimension is larger
than 1/2 of the thickness of the lift being placed.

In the construction of filled areas, starting layers shall be placed in the deepest portion of
the fill, and as placement progresses, additional layers shall be constructed in horizontal planes.
Original slopes shall be continuously, vertically benched to provide horizontal fill planes. The
size of the benches shall be formed so that the base of the bench is horizontal and the back of the
bench is vertical. As many benches as are necessary to bring the site to final grade shall be
constructed. Filling operations shall begin on the lowest bench, with the fill being placed in
horizontal eight (8) inch thick loose lifts unless otherwise authorized. The filling shall progress
in this manner until the entire first bench has been filled, before any fill is placed on the succeeding benches. Proper drainage shall be maintained at all times during benching and filling of the benches, to insure that all water is drained away from the fill area.

Frozen material shall not be placed in the fill nor shall the fill be placed upon frozen material.

The Contractor shall be responsible for the stability of all fills made under the contract, and shall replace any portion, which in the opinion of the Owner or his designated representative, has become displaced due to carelessness or negligence on the part of the Contractor. Fill damaged by inclement weather shall be repaired at the Contractor's expense.

5.0 **SLOPE RATIO AND STORM WATER RUN-OFF**

Slopes shall not be greater than 2 (horizontal) to 1 (vertical) in both cut and fill, or as illustrated on the construction drawings. Excavations shall be constructed in accordance with all Federal, State and local codes relative to slope geometry.

6.0 **GRADING**

The Contractor shall furnish, operate, and maintain such equipment as is necessary to construct uniform layers, and control smoothness of grade for maximum compaction and drainage.

7.0 **COMPACTING**

The compaction equipment shall be approved equipment of such design, weight, and quantity to obtain the required density in accordance with these specifications.

8.0 **TESTING AND INSPECTION SERVICES**

Testing and inspection services will be provided by the Owner.
SECTION III

BORING LOGS, LAB TESTING RESULTS, & PRINTS
BORING LOG TERMINOLOGY

**STRATUM DEPTH**

Distance in feet and/or inches below ground surface.

**STRATUM ELEVATION**

Elevation in feet below ground surface elevation.

**DESCRIPTION OF MATERIALS**

Major types of soil material existing at boring location. Soil classification based on one of the following systems: Unified Soil Classification System, Ohio State Highway Classification System, Highway Research Board Classification System, Federal Aviation Authority Classification System, Visual Classification.

**SAMPLE NO.**

Sample numbers are designated consecutively, increasing with depth for each boring.

**SAMPLE TYPE**

“A” Split spoon, 2” O.D., 1-3/8” I.D., 18” in length.

“B” One of the following:

- Power Auger Sample
- Piston Sample
- Diamond Bit NX: BX: AX:
- Housel Sample
- Wash Sample
- Denison Sample

“C” Shelby Tube 3” O.D. except where noted.

**SAMPLE DEPTH**

Depth below top of ground at which appropriate sample was taken.

**BLOWS PER 6” ON SAMPLER**

The number of blows required to drive a 2” O.D., 1-3/8” I.D., split spoon sampler, using a 140 pound hammer with a 30 inch free fall, is recorded for 6” drive increments. (Example: 3/8/9)

“N” BLOWS/FT.

Standard penetration resistance. This value is based on the total number of blows required for the last 12” of penetration. (Example: 3/8/9 : . N = 8 + 9 = 17)
WATER OBSERVATIONS

Depth of water recorded in test boring is measured from top of ground to top of water level. Initial depth indicates water level during boring, completion depth indicates water level immediately after boring, and depth of "X" number hours indicates water level after letting water rise or fall over a time period. Water observations in pervious soil are considered reliable ground water levels for that date. Water observations in impervious soils can not be considered accurate ground water measurements for that date unless records are made over several days' time. Factors such as weather, soil porosity, etc., will cause the ground water level to fluctuate for both pervious and impervious soils.

SOIL DESCRIPTION

COLOR

When the color of the soil is uniform throughout, the color recorded will be such as brown, gray, black and may be modified by adjectives such as light and dark. If the soil's predominant color is shaded by a secondary color, the secondary color precedes the primary color, such as: gray-brown, yellow-brown. If two major and distinct colors are swirled throughout the soil, the colors will be modified by the term mottled, such as: mottled brown and gray.

<table>
<thead>
<tr>
<th>PARTICLE SIZE</th>
<th>VISUAL</th>
<th>SOIL COMPONENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Larger than 8&quot;</td>
<td>Major Component</td>
</tr>
<tr>
<td>Cobble</td>
<td>8&quot; to 3&quot;</td>
<td>Gravel</td>
</tr>
<tr>
<td>Gravel—Coarse</td>
<td>3&quot; to ¼&quot;</td>
<td>Sand</td>
</tr>
<tr>
<td>Fine</td>
<td>2 mm. To ¾&quot;</td>
<td>Silt</td>
</tr>
<tr>
<td>Sand —Coarse</td>
<td>2 mm.-0.6 mm. (Pencil lead size)</td>
<td>Clay</td>
</tr>
<tr>
<td>—Medium</td>
<td>0.6 mm.-0.2 mm. (Table sugar and salt size)</td>
<td>Moisture Content</td>
</tr>
<tr>
<td>—Fine</td>
<td>0.2 mm.-0.06 mm. (Powdered sugar and human hair size)</td>
<td>Dry</td>
</tr>
<tr>
<td>Silt</td>
<td>0.06 mm.-0.002 mm.</td>
<td>Moist</td>
</tr>
<tr>
<td>Clay</td>
<td>0.002 and smaller (Particle size of both Silt and Clay not visible to naked eye)</td>
<td>Wet</td>
</tr>
</tbody>
</table>

Condition of Soil Relative to Compactness Granular Material

<table>
<thead>
<tr>
<th>Condition of Soil Relative to Compactness Granular Material</th>
<th>Condition of Soil Relative to Consistency Cohesive Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose 5 blows/ft. or less</td>
<td>Very Soft 3 blows/ft. or less</td>
</tr>
<tr>
<td>Loose 6 to 10 blows/ft.</td>
<td>Soft 4 to 5 blows/ft.</td>
</tr>
<tr>
<td>Medium Dense 11 to 30 blows/ft.</td>
<td>Medium Stiff 6 to 10 blows/ft.</td>
</tr>
<tr>
<td>Dense 31 to 50 blows/ft.</td>
<td>Stiff 11 to 15 blows/ft.</td>
</tr>
<tr>
<td>Very Dense 51 blows/ft. or more</td>
<td>Very Stiff 16 to 30 blows/ft.</td>
</tr>
<tr>
<td></td>
<td>Hard 31 blows/ft. or more</td>
</tr>
</tbody>
</table>
STANDARD PENETRATION RESISTANCE (ASTM D1586)

The purpose of this test is to determine the relative consistency of the soils in a boring, or from boring to boring over the site. This method consists of making a hole in the ground and driving a 2 inch O.D. split spoon sampler into the soil with a 140 pound hammer dropped from a height of 30 inches. The sampler is driven 18 inches and the number of blows recorded for each 6 inches of penetration. Values of standard penetration (N) are determined in blows per foot, summarizing the blows required for the last two 6 inch increments of penetration. (Example: 2-6-8; N = 14)

THIN-WALLED SAMPLER (ASTM D1587)

The purpose of the thin-walled sampler is to recover a relatively undisturbed soil sample for laboratory tests. The sampler is a thin-walled seamless tube with a 3 inch outside diameter, which is hydraulically pressed into the ground, at a constant rate. The ends are then sealed to prevent moisture loss, and the tube is returned to the laboratory for tests.

UNCONFINED COMPRESSION OR TRIAXIAL TESTS (ASTM D2166)

The unconfined compression test and the triaxial tests are performed to determine the shearing strength of the soil, to use in establishing its safe bearing capacity. In order to perform the unconfined compression tests, it is necessary that the soil exhibit sufficient cohesion to stand in an unsupported cylinder. These tests are normally performed on samples which are 6.0 inches in height and 2.85 inches in diameter. In the triaxial test, various lateral stresses can be applied to more closely simulate the actual field conditions. There are several different types of triaxial tests. These are, however, normally performed on constant strain apparatus with a deformation rate of 0.05 inches per minute.

CONSOLIDATION TEST (ASTM D2435)

The purpose of this test is to determine the compressibility of the soil. This test is performed on a sample of soil which is 2.5 inches in diameter and 1.0 inch in height, and has been trimmed from relatively “undisturbed” samples. The test is performed with a level system or an air activated piston for applying load. The loads are applied in increments and allowed to remain on the sample for a period of 24 hours. The consolidation of the sample under each individual load is measured and a curve of void ratio vs. Pressure is obtained. From the information obtained in this manner and the column loads of the structure, it is possible to calculate the settlement of each individual building column. This information, together with the shearing strength of the soil, is used to determine the safe bearing capacity for a particular structure.

REVISED TO ASTM D4318

ATTERBERG LIMITS (ASTM D423 AND D424)

These tests determine the liquid and plastic limits of soils having a predominant percentage of fine particle (silt and clay) sizes. The liquid limit of a soil is the moisture content expressed as a percent at which the soil changes from a liquid to a plastic state, and the plastic limit is the moisture content at which the soil changes from a plastic to a semi-solid state. Their difference is defined as the plasticity index (P.I. = L.L. - P.L.), which is the change in moisture content required to change the soil from a “semi-solid” to a liquid. These tests furnish information about the soil properties which is important in determining their relative swelling potential and their classifications.
MECHANICAL ANALYSIS (ASTM D422)

This test determines the percent of each particle size of a soil. A sieve analysis is conducted on particle sizes greater than a No. 20 sieve (0.074 mm), and a hydrometer test on particles smaller than the No. 200 sieve. The gradation curve is drawn through the points of cumulative per cent of particle size, and plotted on semi-logarithmic paper for the combined sieve and hydrometer analysis. This test, together with the Atterberg Limits tests, is used to classify a soil.

NATURAL MOISTURE CONTENT (ASTM D2216)

The purpose of this test is to indicate the range of moisture contents present in the soil. A wet sample is weighed, placed in the constant temperature oven at 105° for 24 hours, and re-weighed. The moisture content is the change in weight divided by the dry weight.

PROCTOR TESTS

The purpose of these tests is to determine the maximum density and optimum moisture content of a soil. The Modified Proctor test is performed in accordance with ASTM D1557-70. The test is performed by dropping a 10 pound hammer 25 times from an 18 inch height on each of 5 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 56,250 foot pounds per cubic foot. The moisture content is then raised, and this procedure is repeated. A moisture density curve is then plotted, with the density on the ordinate axis and the moisture content on the abscissa axis. The moisture content at which the maximum density requirement can be achieved with a minimum compactive effort is designated as the optimum moisture content (O.M.C.). The Standard Proctor test is performed in accordance with ASTM D698-70. This test is similar to the Modified Proctor test and is performed by dropping a 5.5 pound hammer 25 times from a height of 12 inches on 3 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 12,375 foot pounds per cubic foot. This test gives proportionately lower results than the Modified Proctor test.
FIELD CLASSIFICATION SYSTEM FOR ROCK EXPLORATION

**Sarpolite**
A transitional material between soil and rock retains the relic structure of the parent rock and exhibits penetration resistance between 60 blows per foot and 100 blows/2 inches of penetration.

**R.O.D.**
Rock Quality Designation; Ratio of the core lengths greater than four inches to the total length of the core run.

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage Core Recovered</th>
<th>R.O.D Rock Quality Description</th>
<th>Description of Rock Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incompetent</td>
<td>Less than 40</td>
<td>0 - 25</td>
<td>very poor</td>
</tr>
<tr>
<td>Competent</td>
<td>40 - 70</td>
<td>25 - 50</td>
<td>poor</td>
</tr>
<tr>
<td>Fairly Competent</td>
<td>70 - 80</td>
<td>50 - 75</td>
<td>fair</td>
</tr>
<tr>
<td>Fairly Continuous</td>
<td>80 - 90</td>
<td>75 - 90</td>
<td>good</td>
</tr>
<tr>
<td>Continuous</td>
<td>90 - 100</td>
<td>90 - 100</td>
<td>excellent</td>
</tr>
</tbody>
</table>

**FIELD HARDNESS:**
(A measure of resistance to scratching or abrasion)

| Very Hard | Cannot be scratched with knife or sharp pick, breaking of hand specimens requires several hard blows of geologist's pick. |
| Hard      | Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen. |
| Moderately | Can be scratched with knife or pick. Gouges or grooves to ⅛ inch deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow. |
| Hard      | Can be grooved or goug ed 1/16 inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1 inch maximum size by hard blows of the point of a geologist's pick. |
| Soft      | Can be gouged or grooved readily with knife or pick point. Can be excavated in chips and pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure. |
| Very soft | Can be carved with knife. Can be excavated with point of pick. Pieces 1 inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail. |

**WEATHERING:**
(The action of the elements in altering the color, texture, and composition of the rock)

| Very slightly | Rock generally fresh, joints stained, some joints may contain thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline. |
| Slightly      | Rock generally fresh, joints stained, and discoloration extends into rock up to 1 inch. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer. |
| Moderately    | Significant; portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some may be decomposed to clay. Rock as dull sound under hammer and has a significant loss of strength compared with fresh rock. |
| Severe        | All rock except quartz discolored or stained. Rock "fabric" clear and evident but reduced in strength to strong soil. In granitoid rocks all feldspars kaolinized to some extent. Some fragments of strong rock usually left. |
| Very severely | All rock except quartz discolored of stained. Rock "fabric" discernible, but mass effectively reduces to "soil" with only fragments of strong rock usually left. |
| Completely    | All rock completely altered to soil-like material. |

**ROCK FRACTURE FREQUENCY:**
(Any break in a rock whether or not it has undergone relative displacement.)

<table>
<thead>
<tr>
<th>Description</th>
<th>Spacing Between Fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely fractured</td>
<td>Less than 1 inch</td>
</tr>
<tr>
<td>Moderately fractured</td>
<td>1 inch to 4 inches</td>
</tr>
<tr>
<td>Slightly fractured</td>
<td>4 inches to 8 inches</td>
</tr>
<tr>
<td>Sound</td>
<td>More than 8 inches</td>
</tr>
</tbody>
</table>

**JOINTS BEDDING, AND FOLIATION:**

<table>
<thead>
<tr>
<th>Joints</th>
<th>Bedding &amp; Filiation</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very close</td>
<td>Very thin</td>
<td>Less than 2 inches</td>
</tr>
<tr>
<td>Close</td>
<td>Thin</td>
<td>2 inches - 1 foot</td>
</tr>
<tr>
<td>Moderately close</td>
<td>Medium</td>
<td>1 foot - 3 feet</td>
</tr>
<tr>
<td>Wide</td>
<td>Thick</td>
<td>3 feet - 10 feet</td>
</tr>
<tr>
<td>Very wide</td>
<td>Very Thick</td>
<td>More than 10 feet</td>
</tr>
</tbody>
</table>

**Notes:** Refers to perpendicular distance between discontinuities

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Angle (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>0 to 5</td>
</tr>
<tr>
<td>Shallow to low angle</td>
<td>5 to 35</td>
</tr>
<tr>
<td>Moderately dipping</td>
<td>35 to 55</td>
</tr>
<tr>
<td>Steep or high angle</td>
<td>55 to 85</td>
</tr>
<tr>
<td>Vertical</td>
<td>85 to 90</td>
</tr>
<tr>
<td>SCALE FT.</td>
<td>STRATUM DEPTH, FT.</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1.0</td>
<td>10&quot;</td>
</tr>
<tr>
<td>2.0</td>
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<tr>
<td>3.0</td>
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<tr>
<td>13.0</td>
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<tr>
<td>14.0</td>
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<tr>
<td>15.0</td>
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<tr>
<td>16.0</td>
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<tr>
<td>17.0</td>
<td>0.0</td>
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<tr>
<td>18.0</td>
<td>0.0</td>
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<tr>
<td>19.0</td>
<td>0.0</td>
</tr>
<tr>
<td>20.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**WATER LEVEL OBSERVATIONS**
- Noted on rods: 14.0 ft.
- At completion: 14.0 ft.
- After ___ hours ___ ft.

**BORING METHOD**
- HSA: Hollow Stem Auger
- MD: Mud Drilling
- CFA: Continuous Flight Auger
- RC: Rock Coring
- DC: Driven Casing
- CA: Casing Advance

**TYPE SAMPLE**
- A: Split Spoon
- B: Rock Core
- C: Shelby Tube
- D: Other

*These Shelby Tube Samples Obtained In An Auxiliary Boring Drilled A Few Feet From This Boring
<table>
<thead>
<tr>
<th>SCALE, FT.</th>
<th>STRATUM DEPTH, FT.</th>
<th>CLASSIFICATION OF MATERIAL</th>
<th>SAMPLE NUMBER &amp; SAMPLE TYPE</th>
<th>DEPTH OF SAMPLE, FT.</th>
<th>BLOWS ON SAMPLER PER SFT (6&quot; INTERVAL)</th>
<th>SPT &quot;N&quot;, OR RECOVERY (IN FOR SHELBY TUBES, % FOR ROCK CORE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>TOPSOIL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>6&quot;</td>
<td>ORIGINAL, medium stiff, brown, silty CLAY, trace sand, trace gravel (moist to wet)</td>
<td>1A</td>
<td>1.0</td>
<td>2.5</td>
<td>2-3-3</td>
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<tr>
<td>2.0</td>
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<td>6.0</td>
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<tr>
<td>7.0</td>
<td>7.0</td>
<td>SANDSTONE rock (highly weathered)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>BOTTOM OF BORING AT 7.5 FEET</td>
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<td></td>
<td></td>
<td>AUGER REFUSAL AT 7.5 FEET</td>
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<td>8.0</td>
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<tr>
<td>19.0</td>
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<tr>
<td>20.0</td>
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<td></td>
</tr>
</tbody>
</table>

**WATER LEVEL OBSERVATIONS**
- Noted on rods: **4.0 ft.**
- At completion: **4.0 ft.**
- After: **-- hours** **-- ft.**

**BORING METHOD**
- Type: A - Split Spoon
- Sample: Samples Obtained In An
- Auxiliary: Auxiliary Boring Drilled A

**Type & Sample**
- **C** - Shelby Tube
- **D** - Other
- **HSA** - Hollow Stem Auger
- **CFA** - Continuous Flight Auger
- **DC** - Driven Casing
- **MD** - Mud Drilling
- **RC** - Rock Coring
- **CA** - Casing Advance

**Report No.:** 22185  **Boring No.:** CBC-2  **Date Std.:** 3/13/19  **Date Finished:** 3/13/19  **Client:** Levin Porter Associates  **Location:** As Shown on the Boring Location Plan  **Method:** 2 ¼" HSA
## BORING LOG

<table>
<thead>
<tr>
<th>STRATUM DEPTH, FT.</th>
<th>CLASSIFICATION OF MATERIAL</th>
<th>SAMPLE NUMBER &amp; SAMPLE TYPE</th>
<th>DEPTH OF SAMPLE, FT.</th>
<th>BLOWS ON SAMPLER PER SPT (6&quot; INTERVAL)</th>
<th>SPT &quot;N&quot;, OR RECOVERY (IN. FOR SHELBY TUBES, % FOR ROCK CORE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>ASPHALT</td>
<td>1A</td>
<td>1.0</td>
<td>2.5</td>
<td>6-18-13</td>
</tr>
<tr>
<td>1.0</td>
<td>GRAVEL BASE</td>
<td>2A</td>
<td>3.5</td>
<td>5.0</td>
<td>7-10-13</td>
</tr>
<tr>
<td>6.0</td>
<td>ORIGINAL, medium stiff, brown, silty CLAY, some sand and gravel (moist)</td>
<td>3A</td>
<td>6.0</td>
<td>7.5</td>
<td>7-13-7</td>
</tr>
<tr>
<td>9.0</td>
<td>Medium dense, brown, SAND and GRAVEL, some silt and clay (moist to wet)</td>
<td>4A</td>
<td>8.5</td>
<td>10.0</td>
<td>5-13-17</td>
</tr>
<tr>
<td>15.0</td>
<td>BOTTOM OF BORING AT 15.0 FEET</td>
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</tr>
</tbody>
</table>

### WATER LEVEL OBSERVATIONS
- Noted on rods: Dry ft.
- At completion: Dry ft.
- After ___ hours ___ ft.

### BORING METHOD
- HSA: Hollow Stem Auger
- CFA: Continuous Flight Auger
- DC: Driven Casing
- MD: Mud Drilling
- RC: Rock Coring
- CA: Casing Advance

### TYPE SAMPLE
- A: Split Spoon
- B: Rock Core
- C: Shelby Tube
- D: Other

*These Shelby Tube samples obtained in an auxiliary boring drilled 15 ft. to 18ft. below the bottom of boring.

---

CBC Engineers & Associates, Ltd.
125 Westpark Road
Centerville, OH 45459
(P) (937) 428-6150 / (F) (937) 428-6154
**BORING LOG**

**CLIENT:** Levin Porter Associates  
**REPORT NO.:** 22185  
**BORING NO.:** CBC-4  
**DATE STD.:** 3/13/19  
**DATE FINISHED:** 3/13/19  
**PROJECT:** GEI-Southdale Elementary, Kettering, OH  
**DRILLERS:** Envirocse  
**LOCATION:** As Shown on the Boring Location Plan  
**GROUND ELEV.:** --  
**METHOD:** 2 1/4" HSA

<table>
<thead>
<tr>
<th>SCALE, FT.</th>
<th>STRATUM DEPTH, FT.</th>
<th>CLASSIFICATION OF MATERIAL</th>
<th>SAMPLE NUMBER &amp; SAMPLE TYPE</th>
<th>DEPTH OF SAMPLE, FT.</th>
<th>BLOWS ON SAMPLER PER SPT (6&quot; INTERVAL)</th>
<th>SPT &quot;N&quot;, OR RECOVERY (IN FOR SHELBY TUBES, % FOR ROCK CORE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>ASPHALT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>9&quot;</td>
<td>GRAVEL BASE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>9&quot;</td>
<td>ORIGINAL, medium stiff, brown, silty CLAY, some sand and gravel (moist)</td>
<td>1A 1.0 2.5 3-3-4 7</td>
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<td></td>
<td></td>
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<tr>
<td>2.0</td>
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</tr>
<tr>
<td>6.0</td>
<td></td>
<td>becomes soft with increased moisture content at 6.0 ft.</td>
<td>3A 6.0 7.5 2-1-1 2</td>
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<tr>
<td>7.0</td>
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<td>12.0</td>
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<td>13.0</td>
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</tr>
<tr>
<td>14.0</td>
<td>14.0</td>
<td>Stiff, brown, clayey SILT, trace sand, trace gravel (moist)</td>
<td>5A 13.5 15.0 2-4-5 9</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>15.0</td>
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<tr>
<td>20.0</td>
<td></td>
<td>BOTTOM OF BORING AT 20.0 FEET</td>
<td></td>
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</tr>
</tbody>
</table>

**WATER LEVEL OBSERVATIONS**
- Noted on rods: Dry ft.
- At completion: Dry ft.
- After ___ hours ___ ft.

**BORING METHOD**
- HSA Hollow Stem Auger
- CFA Continuous Flight Auger
- DC Driven Casing
- MD Mud Drilling
- RC Rock Coring
- CA Casing Advance

**TYPE SAMPLE**
- A - Split Spoon
- B - Rock Core
- C - Shelby Tube
- D - Other

*These Shelby Tubes were obtained from borings 9, 10 and 11. Few Feet from This Boring...
<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>DEPTH INCREMENT, (FT.)</th>
<th>NATURAL MOISTURE CONTENT, %</th>
</tr>
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<tbody>
<tr>
<td>CBC-1</td>
<td>1.0 – 2.5</td>
<td>26.3</td>
</tr>
<tr>
<td>CBC-1</td>
<td>3.5 – 5.0</td>
<td>12.4</td>
</tr>
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<td>CBC-1</td>
<td>6.0 – 7.5</td>
<td>12.3</td>
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<td>CBC-1</td>
<td>8.5 – 10.0</td>
<td>9.3</td>
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<td>CBC-1</td>
<td>13.5 – 15.0</td>
<td>12.3</td>
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<td>CBC-2</td>
<td>1.0 – 2.5</td>
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<td>CBC-2</td>
<td>3.5 – 5.0</td>
<td>13.8</td>
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<td>9.6</td>
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<td>CBC-3</td>
<td>3.5 – 5.0</td>
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</tr>
<tr>
<td>CBC-3</td>
<td>6.0 – 7.5</td>
<td>8.9</td>
</tr>
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<td>13.5 – 15.0</td>
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<td>3.5 – 5.0</td>
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<td>6.0 – 7.5</td>
<td>19.8</td>
</tr>
<tr>
<td>CBC-4</td>
<td>13.5 – 15.0</td>
<td>14.6</td>
</tr>
<tr>
<td>CBC-4</td>
<td>18.5 – 20.0</td>
<td>18.8</td>
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</table>
VICINITY MAP
GEOTECHNICAL ENGINEERING INVESTIGATION FOR ADDITIONS TO ORCHARD PARK AND SOUTHDALE ELEMENTARY SCHOOLS, KETTERING, OHIO

SITE (SOUTHDALE)

SITE (ORCHARD PARK)

PROJECT NO.
CBC-22185

SCALE
1" = 2400'

ENGINEERS

FIGURE NO. 1
NOTE: POINT "A" OF SHALLOWER FOOTING MUST BE SITUATED BELOW THE DASHED LINE SHOWING THE FOOTING LOCATION LIMIT.
LEGEND:
P = MINIMUM DOWNWARD LOAD
f = COEFFICIENT OF FRICTION
     AT CONCRETE/SOIL INTERFACE
F = MAXIMUM HORIZONTAL FORCE
W_F = WEIGHT OF FOOTING BELOW FINAL GRADE
q = RESISTING PASSIVE PRESSURE
LEGEND:

- \( Q \) = Maximum Uplift Load
- \( \gamma_s H \) = Total Soil Unit Weight
- \( W_F \) = Weight of Footing Below Final Grade
LEGEND:

\( \gamma_s \) = TOTAL SOIL UNIT WEIGHT, (lbs./cu. ft.)

\( K_0 \) = AT REST EARTH PRESSURE COEFFICIENT

DESIGN ILLUSTRATION:
LATERAL EARTH PRESSURE AGAINST NON-YIELDING BELOW-GRADE WALL
ASSUMING DRAINED BACKFILL WITH NON-HYDROSTATIC PRESSURE
DESIGN ILLUSTRATION:
SHALLOW FOOTINGS IN AN UNDERCUT AREA

SCALE: NONE
FIGURE NO.: 7
SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS


B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for dust control. Indicate proposed locations and construction of barriers.

C. Schedule of selective demolition activities with starting and ending dates for each activity.

D. Predemolition photographs or video.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.5 CLOSEOUT SUBMITTALS

A. Inventory of items that have been removed and salvaged.
1.6 QUALITY ASSURANCE
   A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.7 FIELD CONDITIONS
   A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
   B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
   D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
      1. Hazardous materials will be removed by Owner before start of the Work.
      2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
   E. Storage or sale of removed items or materials on-site is not permitted.
   F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
      1. Maintain fire-protection facilities in service during selective demolition operations.
   G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.8 WARRANTY
   A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

C. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Arrange to shut off utilities with utility companies.
   2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
      a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
      b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
      c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
      d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

4. Maintain fire watch during and for at least one-half hour after flame-cutting operations.

5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

6. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers.

3. Store items in a secure area until delivery to Owner.

4. Transport items to Owner's storage area on-site.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 CLEANING

A. Remove demolition waste materials from Project site.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119
SECTION 033000 – CAST-IN-PLACE CONCRETE
When the information in this Specification Section conflicts with information on the Structural Construction Drawings, the Structural Construction Drawings shall prevail.

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 ACTION SUBMITTALS
A. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site. Water shall not be permitted to be added at the site without this criteria completed on the shop drawing review.

B. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Include plans and sections, and when necessary also include elevations.

C. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Location of construction joints is subject to approval of the Architect. Work joint layout to coincide with any terrazzo jointing.

1.3 INFORMATIONAL SUBMITTALS
A. Material Certificates: For each of the following, signed by manufacturers:
   1. Fiber reinforcement.
   2. Waterstops.
   3. Curing compounds.
   4. Floor and slab treatments.
   5. Vapor retarders.

B. Slab Jointing Plan: Contractor to indicate location of slab-on-grade contraction joints and construction joints.
   1. Joints shall be spaced in a square or rectangular pattern with aspect ratio not to exceed 1.5:1.
   2. Spacing shall not exceed 36 times the slab thickness (in inches).
C. Field quality-control reports, including floor surface flatness and levelness measurements indicating compliance with specified tolerances.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.5 QUALITY ASSURANCE

A. Quality Standard: ACI 301.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.

C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.7 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1.

1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 117.
2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.
   2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      a. High-density overlay, Class 1 or better.
      b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
      c. Structural 1, B-B or better; mill oiled and edge sealed.
      d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Chamfer Strips: Wood, metal, PVC, or rubber strips.

C. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide rust inhibitor.

D. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 CONCRETE MATERIALS

A. Cementitious Materials:
   2. Fly Ash: ASTM C 618, Class F or C.
   3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S, graded.
   1. Maximum Coarse-Aggregate Size: 1 inch nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.


D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

E. Water: ASTM C 94 and potable.

2.4 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Epoxy-Coated Reinforcing Bars: ASTM A 615, Grade 60, deformed bars, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.

2.5 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

B. Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

C. Epoxy-Coated Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, ASTM A 775 epoxy coated.

D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775.

2.6 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Blended monofilament and fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, no less than 2 inches long.
   1. Forta-Ferro, Forta Corporation
   2. Tuff-Strand, Euclid

2.7 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
2.8 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A, 15 mils thick low-permeance polyolefin with Water Vapor Permeance (ASTM E96): 0.025 gr./ft²/hr. or lower. Include manufacturer's recommended adhesive or pressure-sensitive tape.
   1. Products shall include:
      a. Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
      b. Fortifiber Building Systems Group; Moistop Ultra 15.
      e. Reef Industries, Inc.; Griffolyn 15 mil.
      f. Stego Industries, LLC; Stego Wrap 15 mil Class A.

2.9 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating: to be used at all concrete floors scheduled to receive applied finish materials.

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A: to be used only at concrete floors not scheduled to receive applied finish materials.

2.10 RELATED MATERIALS


B. Round Concrete Cast-In-Place Column Fiber Forms: Multiple layers of 100 percent recycled paperboard, spirally wound, and laminated with adhesive.
   1. Interior Surface: Smooth with spiral seam. Alathon release and moisture barrier coating.
   2. Exterior Surface: Micryl moisture barrier coating.
   4. 1-piece, 1-time-use forms.
   5. Recyclable.
2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 25 percent.
   4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

C. Admixtures: Use admixtures according to manufacturer’s written instructions.
   1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   2. Use water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Trench Footings, Footings, and Interior Foundations: Proportion Normal-Weight Concrete mixture as follows:
   1. Minimum Compressive Strength: 3000 psi at 28 days.
   2. Maximum W/C Ratio: 0.53.
   3. Slump Limit: 4 inches, plus or minus 1 inch.

B. Foundation and Retaining Walls exposed to Exterior: Proportion Normal-Weight Concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   2. Maximum W/C Ratio: 0.48.
   3. Slump Limit: 5 inches, plus or minus 1 inch.
   4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
   5. Mid-Range Water Reducer Required

C. Exterior Slabs-on-Grade walks, stoops, steps, aprons, and curbs; exterior formed concrete exposed to view; exterior concrete not otherwise indicated: Proportion Normal-Weight Concrete mixture as follows:
   1. Minimum Compressive Strength: 4500 psi at 28 days.
   3. Maximum W/C Ratio: 0.45.
   4. Slump Limit: 4 inches, plus or minus 1 inch.
   5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
6. Finish: Nonslip Broom Finish

D. Interior Slabs-on-Grade including Equipment Housekeeping Pads: Proportion Normal-Weight Concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum W/C Ratio: 0.48.
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
6. Mid-Range Water Reducer Required
7. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of 3.0 lb/cu. yd.

E. Metal stair pan fill: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 2500 psi at 28 days.
4. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

F. Flowable Fill – Type 1 - Utility Trench Backfill: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 100 psi at 28 days.
2. Unconfined compression strength per ASTM D4832

G. Flowable Fill – Type II (option) – Under Foundations: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 100 psi at 28 days.
2. Unconfined compression strength per ASTM D4832

H. Lean Concrete fill at soft soils: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 1500 psi at 28 days.

2.13 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   2. Class C, 1/2 inch for rough-formed finished surfaces.

D. Chamfer exterior corners and edges of permanently exposed concrete.

E. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

F. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

G. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

B. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.3 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.4 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

B. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

C. Coordinate pipe, sleeves, conduits, and other utilities prior to placing concrete.

3.5 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Vapor Retarder is to be used directly below slab-on-grade.

2. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.

2. Space vertical joints in walls not to exceed the guidelines as described on the contract documents. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: Install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
   4. Provide round isolation joints at all steel columns. Size round column fiber forms to maintain minimum 1-1/2” clearance of base plate.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 WATERSTOP INSTALLATION

A. Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions. Install in longest lengths practicable.

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project Site, or during placement unless explicitly noted on approved mix design.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish (Rffm-Fn): As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish (SMFm-Fn): As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
1. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finishes: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Float Finish (Flt-Fn) - Noncritical Floors
   a. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, subfloors under concrete toppings, thickef tile, sand bed terrazzo, and raised computer floors.
   b. Finish surfaces to the following tolerances, according to ASTM E 1155:
      1) Specified overall values of flatness, F(F) 20; and of levelness, F(L) 15; with minimum local values of flatness, F(F) 14; and of levelness, F(L) 10.

C. Trowel Finishes: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Trowel Finish 1 (Tr-Fn1) – Carpeted Floors, unless otherwise noted
   a. Apply trowel finish to monolithic slab surfaces that are to receive carpet and noncritical floors where slabs remain exposed, such as mechanical rooms, unless otherwise noted.
   b. Finish surfaces to the following tolerances, according to ASTM E 1155:
      1) Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17.

2. Trowel Finish 2 (Tr-Fn2) – Floors with improved flatness/levelness requirements.
   a. Apply trowel finish to monolithic slab surfaces that are to receive thin-set flooring, resilient flooring, linoleum flooring, fluid-applied flooring, resinous flooring and other flooring types, unless otherwise indicated.
      1) At thin-set tile floors, maximum permissible variation shall be ¼ inch to 10 feet from required plane. After surface is steel troweled and while concrete is still plastic, apply a fine broom finish.
   b. Finish surfaces to the following tolerances, according to ASTM E 1155:
      1) Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17.

3. Trowel Finish 3 (Tr-Fn3) – Floors requiring better than average flatness/levelness.
   a. Apply trowel finish to monolithic slab surfaces that are scheduled to receive a polished concrete finish, unless otherwise noted.
   b. Finish surfaces to the following tolerances, according to ASTM E 1155:
      1) Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
4. Trowel Finish 4 (Tr-Fn4)
   a. Apply trowel finish to wood covered floors, and with other floor finishes as indicated in their technical sections and required by their manufacturers
   b. The slab shall be steel troweled to a true level and finished smooth and straight to a tolerance of 1/8 inch in any 10 foot radius.

D. Nonslip Broom Finish (NsBrm-Fn): Apply a nonslip broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Equipment Housekeeping Pads:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
   3. Install hooked dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete substrate.
   5. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
C. Formed Surfaces: Cure formed concrete surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar. Notify Architect of repairs and provide detailed methods for approval prior to beginning repairs.

C. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface. Defects also include stains and other discolorations in public view that cannot be removed by cleaning.

   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of
cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

3.14 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel reinforcement placement.
2. Headed bolts and studs.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
5. Unit Weight: ASTM C 567; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compressive-Strength Tests: ASTM C 39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may not be used.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.
END OF SECTION 033000
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All provisions of the Contract Documents apply to this Section. The Contractor for this Section shall be responsible for complete familiarity with same.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, services and equipment required to complete all masonry work as specified herein and as indicated on the Drawings. Work shall include, but not be limited to, the following:

1. Concrete masonry units and lintels
2. Mortar
3. Wall reinforcing and masonry accessories
4. Cleaning of masonry

1.4 QUALITY ASSURANCE

A. Fire-rated masonry: Whenever a fire-resistance classification is shown or scheduled for unit masonry construction, comply with applicable requirements for materials and installation established by the American Insurance Association and other governing authorities. Provide certification from manufacturer that masonry units provided for the project conform to rating requirements.

B. Codes: Comply with the applicable requirements of governing authorities and codes for the types of masonry construction shown.

C. Coordination: Review installation procedures and coordinate with other work that must be integrated with masonry.

D. Construction Tolerances:

1. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20' nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more.

2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4" in any bay or 20' maximum.

3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 1/2" in any bay or 20' maximum.
4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4" nor plus 1/2".

1.5 SUBMITTALS

A. Product Data:

1. Submit manufacturer's specifications and other data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements. Include instructions for handling, storage, installations and protection.

1.6 JOB CONDITIONS

A. Protection of Work: During erection, cover top of walls with heavy waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress.

B. Extend cover a minimum of 24" down both sides and hold cover securely in place.

C. Do not apply uniform floor or roof loading for at least 12 hours after building masonry walls or columns.

D. Do not apply concentrated loads for at least 3 days after building masonry walls or columns.

E. Staining: Prevent grout or mortar from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry.

F. Protect sills, ledges and projections from droppings of mortar.

1.7 COLD WEATHER PROTECTION

A. Do not lay masonry units which are wet or frozen.

B. Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch.

C. Remove all masonry determined to be frozen or damaged by freezing conditions.

D. Perform the following construction procedures while the work is progressing:

1. When air temperature is from 40°F (0°C) to 25°F (-4°C), heat sand or water to produce mortar temperature between 40°F (4°C) and 120°F (49°C); maintain temperature of mortar on boards above freezing.

2. When air temperature is from 25°F (-4°C) to 20°F (-7°C), heat sand and mixing water to produce mortar temperatures between 40°F (4°C) and 120°F (49°C); maintain temperature of mortar on boards above freezing; using only temporary heating appliances approved by the City, provide heat sources on both sides of walls under construction, use wind breaks when wind is in excess of 15 mph.
3. When air temperature is 20°F (-7°C) and below heat sand and mixing water to produce mortar temperatures between 40°F (4°C) and 120°F (49°C), provide enclosures and auxiliary heat to maintain air temperature above 32°F (0°C); do not lay units which have a surface temperature of 20°F (-7°C).

E. Perform the following protections for completed masonry and masonry not being worked on:

1. When the mean daily air temperature is from 40°F (4°C) to 32°F (0°C), protect masonry from rain or snow for at least 24 hours by covering with weather-resistant membrane.

2. When mean daily air temperature is from 32°F (0°C) to 25°F (-4°C), completely cover masonry with weather-resistant membrane for at least 24 hours.

3. When mean daily air temperature is from 25°F (-4°C) to 20°F (-7°C), completely cover masonry with insulating blankets or similar protection for at least 24 hours.

4. When mean daily temperature is 20°F (-7°C) and below, maintain masonry temperature above 32°F (0°C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps, or other acceptable methods.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

Manufacturer: Obtain masonry units of each type from one manufacturer, of uniform texture and color. Products of manufacturers other than those listed below shall be considered subject to compliance with performance requirements, aesthetic intent, and shall be approved in writing prior to submission of the Proposal.

A. Concrete Masonry Units (CMU):

1. Size: Manufacturer's standard units with nominal face dimensions of 16" long x 8" and 16” long by 12” (15-5/8" x 7-5/8" and15-5/8" x 11-5/8" actual), unless otherwise indicated.

2. Special Shapes: Provide where required for lintels, corners, jambs, sash, control joints, headers, bonding and other special conditions. All exposed corners and header edges shall have bullnose corner/edge. Provide special bull-nosed edges at intersection of jambs to headers.

3. Hollow Load-bearing CMU: ASTM C 90 where shown, and as follows:
   a. Grade N for general use in exterior walls above and below grade that may or may not be exposed to moisture penetration or the weather, and for interior walls and backup.

4. Solid Loadbearing CMU: ASTM C 145, where shown, and as follows:
2.2 BRICK VENEER

A. Basis of Design: Belden Brick Company, Modular Carolina Rose A, 17-25 or equal to match existing “red” brick.
B. Size: Modular.

2.3 MORTAR MATERIALS

A. Mortar Color and Texture:
   1. Concrete Unit Masonry: Natural
B. Portland Cement: ASTM C 150 - Type 1.
C. Hydrated Lime: ASTM C 207, Type S.
D. Aggregates: ASTM C 144
E. Water: Clean, free of deleterious materials which would impair strength or bond.

2.4 MASONRY ACCESSORIES

A. Horizontal Joint Reinforcement for Concrete Unit Masonry: In single wythe walls and in backing wythe of cavity walls, use 9 ga. deformed wire ladder or truss type; in composite walls, use continuous rectangular tab tie type with 9 ga. deformed side rods and 3/16" steel wire tab ties.
B. All reinforcement and ties in exterior walls to have Class B-2 finish, hot-dipped galvanized after fabrication, and regular mill galvanized finish for remaining areas.
C. Provide reinforcement 2" less in width than wythe thickness; use either prefabricated or job-fabricated corners and ties.
D. Anchoring Devices:
   1. Wall to Wall: 1/4" x 1-1/4" x 2'-4" steel strap anchors with bent ends for bonding intersecting bearing walls. 4" x 24" x 1/4" mesh galvanized steel lath for bonding intersecting non-bearing walls.
   2. Wall to Column: 1/8" x 1" x 1'-4" steel strap anchors with bent ends for bonding intersecting bearing and non-bearing walls to steel columns.
E. Flashings and Expansion Joint Strips for Masonry:
   1. Concealed Flashings: Virgin polyvinyl chloride with plasticizers and other modifiers, formed into uniform flexible sheets not less than 20-mils thick and black in color, unless otherwise indicated.

F. Mortar and Grout Mixes:
   1. Do not lower the freezing point of mortar by use of admixtures or antifreeze agents.
   2. Do not use calcium chloride in mortar or grout.
   3. Mortar for unit masonry: Comply with ASTM C 270, Proportion Specifications, except limit materials to those specified herein, and limit cement/lime ratio (by volume) as follows:

      For all masonry: Type S; over 1/4 up to 1/2 part lime per part of portland cement.

G. Waterstops: Johns-Manville non-insulated with perforated stainless steel flanges and neoprene bellows.

H. Miscellaneous Masonry Accessories:

   A. Compressible Filler/Thermal Break: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
      1. Products:
         a. Neo-Seal IV 2218-3; Williams Products, Inc.
         c. #NS-Closed Cell Neoprene Sponge; Hohmann and Barnard, Inc.
         d. Neocell; IPCO
         e. #NS-Closed Cell; National Construction Materials Corp.

   B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

   C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

I. MASONRY-CELL INSULATION

   1. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to
comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.

2.5 REINFORCED MASONRY

A. Reinforcing: Conform to concrete reinforcing steel requirements specified in Section 03300.

B. Grout:

1. Coarse Aggregates: Proportion in accordance with ASTM C476.
2. Cement: Portland cement, ASTM C150, Type I.
3. Slump: 8" ± 1".
4. Strength: 3,000 psi minimum @ 28 days.
5. Aggregates: ASTM C404, maximum size course aggregate = 3/8" (pea gravel).

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL

A. Thickness: Build masonry construction to the full thickness shown, except, build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness shown or specified.

B. Cut masonry units with motor-driven saw designed to cut masonry with clean sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining work neatly. Use full units without cutting wherever possible.

C. Frozen Materials and Work: Do not use frozen materials or materials mixed or coated with ice or frost. For masonry which is specified to be wetted, comply with the BIA recommendations. Do not build on frozen work. Remove and replace masonry work damaged by frost or freezing.

D. Pattern Bond: Lay exposed masonry in the bond pattern to match existing unless otherwise shown on the drawings. Lay concealed masonry with all units in a wythe bonded by lapping not less than 2". Bond and interlock each course of each wythe at corners, unless otherwise shown.

E. Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs and wherever possible at other locations.

F. Stopping and Resuming Work: Rack back 1/2 masonry unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if specified to be wetted), and remove loose masonry units and mortar prior to laying fresh masonry.
G. Build-In Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.

1. Fill space between hollow metal frames and masonry solidly with mortar.

2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or ground into core.

H. Non-Loadbearing Interior Partition Walls: Build full height of story to underside of solid structure above, unless otherwise indicated.

3.2 MASONRY MORTAR BEDDING AND JOINTING

Use Type S mortar for exterior above grade loadbearing and non-loadbearing walls, parapet walls, pavements, and for interior loadbearing walls and non-loadbearing partitions.

A. Batch Control:

1. Measure and batch materials either by volume or weight, such that the required proportions for mortar can be accurately controlled and maintained. Measurement of sand exclusively by shovel will not be permitted.

2. Mix mortars with the maximum amount of water consistent with workability to provide maximum tensile bond strength within the capacity of the mortar.

3. Mix mortar ingredients for a minimum of 5 minutes in a mechanical batch mixer. Use water clean and free of deleterious materials which would impair the work. Do not use mortar which has begun to set.

4. Lay brick and other solid masonry units with completely filled bed, head and collar joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

5. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells; also bed webs in mortar in starting course on footings and foundation walls and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or to be filled with concrete or grout.

6. Joints: Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not otherwise indicated, or required to match existing, lay walls with 3/8" joints. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials. Tool exposed joints slightly concave. Rake out mortar in preparation for application of caulking or sealants where shown.

7. Remove masonry units disturbed after laying; clean and relay in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

8. Back parget full 3/8" all new or existing face brick accessible to the construction.
3.3 HORIZONTAL JOINT REINFORCING

A. Provide continuous horizontal joint reinforcing as shown and specified. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls and 1/2" at other locations. Lap reinforcement a minimum of 6" at ends of units. Do not bridge control and expansion joints with reinforcing, unless otherwise indicated. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections.

B. For single-wythe walls, space reinforcing at 16" o.c. vertically, unless otherwise indicated.

C. Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcing placed in 2 horizontal joints approximately 8" apart, both immediately above the lintel and below the sill. Extend reinforcing a minimum of 2'-0" beyond jambs of the opening, bridging control joints where provided.

3.5 LINTELS: Install loose lintels of steel and other materials where shown.

3.6 CONTROL AND EXPANSION JOINTS

A. Provide vertical expansion, control and isolation joints in masonry where shown. Build-in related masonry accessory items as the masonry work progresses.

B. Coordinate installation of expansion joints as noted in structural drawings.

3.7 FLASHING OF MASONRY WORK

A. Provide concealed flashings in masonry work at, or above, all shelf angles, lintels, ledges and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Prepare masonry surfaces smooth and free from projections which could puncture flashing. Place thruwall flashing on bed of mortar and cover with mortar. Seal penetrations in flashing with mastic before covering with mortar.

B. Install elastic flashing without stretching. Install elastic flashing filler strips to provide for movement by forming loops or bellows in width of flashing. Locate filler strips to facilitate complete drainage of water from flashing. Seam flashing sheets with adhesive, and anchor edges in manner indicated.

C. Extend flashings the full length of lintels and shelf angles and extend flashing a minimum of 4" into masonry each end. Extend flashing from a line 1/2" in from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4", and through the inner wythe to within 1/2" of the interior face of the wall in exposed work.

Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2". At heads and sills turn up ends not less than 2" to form a pan.

D. Interlock end joints of deformed metal flashings by overlapping deformations not less than 1-1/2" and seal lap with elastic sealant.
E. Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

3.8 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Clean all exposed brick masonry and limestone surfaces by the bucket and brush hand cleaning method. High pressure water cleaning is permissible if Contractor submits outline of proposed method, including maximum pressure, for approval. All cleaning agents are subject to Architect's approval. Before applying any cleaning agent to the entire wall, apply it to a small sample wall area of approximately 20 sq. ft. in a location approved by the Architect. Do not proceed with cleaning until the sample area has been approved by the Architect. Protect all sash, metal lintels, louvers and other corrodiible parts. Damaged materials and work shall be replaced at Contractor's expense.

1. If acidic compounds are required for cleaning face brick, all limestone work must be protected as acidic compounds may burn and discolor limestone. Approval to use acidic compounds will be given only under special circumstances.

2. Use of sandblasting, wire brushes, or muriatic acid is strictly prohibited.

3.9 MASONRY-CELL INSULATION

A. Install molded-polystyrene insulation units into masonry unit cells at locations noted on the drawings before laying units per manufacturer’s requirements.

3.10 APPLY FINISHES

A. Apply skim coat mix over masonry, where required, to accommodate direct application of finish materials or coatings to masonry units, as required by finish materials/coatings manufacturer in order to achieve desired final finish appearance. Coordinate with other applicable sections herein this Project Manual.

3.11 REINFORCED MASONRY

A. For lintels, brick beams, and other reinforced work comply with ANSI A41.2 "Building Code Requirements for Reinforced Masonry".

END OF SECTION 04 20 00
SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL
When the information in this Specification Section conflicts with information on the Structural Construction Drawings, the Structural Construction Drawings shall prevail.

1.1 SUMMARY
A. Section Includes:
   1. Structural steel.
   2. Field-installed shear connectors.
B. Related Requirements:
   1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
   2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.

1.2 DEFINITIONS
A. Applicable building code: Building code under which the structure is designed. Unless noted otherwise this shall refer to the latest edition, including all supplements, addendums, and updates, of the Ohio Building Code.
B. Authority having jurisdiction (AHJ): Organization, political subdivision, office or individual charged with the responsibility of administering and enforcing the provisions of the applicable building code.
C. Engineer of record (EOR): Licensed professional responsible for sealing the structural design drawings and specifications.
D. Nondestructive testing (NDT): Inspection procedure wherein no material is destroyed and the integrity of the material or component is not affected.
E. Quality Assurance (QA): Monitoring and inspection tasks performed by an agency or firm other than the fabricator or erector to ensure that the material provided and work performed by the fabricator and erector meet the requirements of the approved construction documents and referenced standards. Quality assurance includes those tasks designated “special inspection” by the applicable building code.
F. Quality Assurance Inspector (QAI): Individual designated to provide quality assurance inspection for the work being performed.
G. Quality Assurance Plan (QAP): Program in which the agency or firm responsible for quality assurance maintains detailed monitoring and inspection procedures to ensure conformance with the approved construction documents and referenced standards.

H. Quality Control (QC): Controls and inspections implemented by the fabricator or erector, as applicable, to ensure that the material provided and work performed meet the requirements of the approved construction documents and referenced standards.

I. Quality Control Inspector (QCI): Individual designated to perform quality control inspection tasks for the work being performed.

J. Quality Control Program (QCP): Program in which the fabricator or erector, as applicable, maintains detailed fabrication or erection and inspection procedures to ensure conformance with the approved design drawings, specifications and referenced standards.

K. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303-10, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   4. Radiographic Inspection: ASTM E 94.

B. American Welding Society (AWS):
   1. Structural Welding Code – Steel (D1.1)

C. American Institute of Steel Construction (AISC)
   1. AISC 303-10 “Code of Standard Practice for Steel Buildings and Bridges.”
   2. AISC 360-10 “Specification for Structural Steel Buildings.”

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.
1.5 PREINSTALLATION MEETINGS

A. A pre-installation meeting with the Contractor, Steel Erector, Special Inspector and the Registered Design Professional is required.
   1. Meeting shall be held at the job site trailer or other mutually agreed upon location.
   2. Contact Registered Design Professional at least two (2) weeks prior to steel installation to arrange meeting date.
   3. An approved Structural Steel Submittal Package shall be completed prior to arrangement of pre-installation meeting.

1.6 ACTION SUBMITTALS

A. Shop Drawings: The fabricator or erector shall submit shop and erection drawings for review by the engineer of record (EOR), in accordance with Section 4 of the Code of Standard Practice, prior to fabrication. Drawings shall include the following:
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include Embedment Drawings for steel elements embedded in masonry or concrete.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
   5. Erection Drawings

B. One (1) hardcopy and one (1) electronic copy (in PDF format) for the structural steel shop drawings shall be submitted for review. The hardcopy of the structural steel shop drawings will be redmarked by SMA. One (1) redmarked hardcopy will be retained by SMA as an office copy. One (1) electronic copy of this redmarked set will be submitted as the approved set. No allowance has been made for redmarking a quantity of hardcopies greater than that noted above. Fees for in-house duplication of redmarks on printed hardcopies may be an Additional Service and invoiced at an hourly rate using Shell + Meyer's Standard Rate Schedule

C. Submittals requiring more than TWO (2) reviews by SMA resulting from errors and omissions of the supplier's detailer will be an Additional Service and invoiced at an hourly rate. An invoice for these services will be attached to the final approved set of shop drawings.

D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs) for Partial Joint Penetration (PJP), Complete Joint Penetration (CJP), and flare bevel groove welds: Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
   1. Power source (constant current or constant voltage).
   2. Electrode manufacturer and trade name.

E. At completion of fabrication, the approved fabricator shall submit a certificate of compliance to the AHJ stating that the materials supplied and work performed by the fabricator are in accordance with the construction documents.
F. At completion of erection, the approved erector shall submit a certificate of compliance to the AHJ stating that the materials supplied and work performed by the erector are in accordance with the construction documents.

1.7 INFORMATIONAL SUBMITTALS

A. The following documents shall be available in electronic or printed form for review by the EOR prior to fabrication or erection, as applicable, unless otherwise required in the contract documents to be submitted:
   1. For main structural steel elements, copies of material test reports in accordance with AISC 360, Section A3.1.
   2. For fasteners, copies of manufacturer’s certifications in accordance with AISC 360, Section A3.3.
   3. For anchor rods and threaded rods, copies of material test reports in accordance with AISC 360, Section A3.4.
   4. For welding consumables, copies of manufacturer’s certifications in accordance with AISC 360, Section A3.5.
   5. For headed stud anchors, copies of manufacturer’s certifications in accordance with AISC 360, Section A3.6.
   6. Manufacturer’s product data sheets or catalog data for welding filler metals and fluxes to be used. The data sheets shall describe the product, limitations of use, recommended or typical welding parameters, and storage and exposure requirements, including baking, if applicable.
   7. Welding procedure specifications (WPSs).
   8. Procedure qualification records (PQRs) for WPSs that are not prequalified in accordance with AWS D1.1/D1.1M or AWS D1.3/D1.3M, as applicable.
   9. Welding personnel performance qualification records (WPQR) and continuity records.
   10. Fabricator’s or erector’s, as applicable, written quality control manual that shall include, as a minimum:
        a. Material control procedures
        b. Inspection procedures
        c. Nonconformance procedures
   11. Fabricator’s or erector’s, as applicable, QC inspector qualifications.
   12. Field quality-control and special inspection reports.

1.8 QUALITY CONTROL

A. Quality control (QC) as referenced in this Specification shall be provided by the fabricator and erector.

B. Nondestructive testing (NDT) shall be performed by the agency or firm responsible for Quality Assurance.

C. Fabricator Qualifications:
   1. 5 years minimum experience
   2. A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD: For Installer.
D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303-10 “Code of Standard Practice for Steel Buildings and Bridges.”
   2. AISC 360-10 “Specification for Structural Steel Buildings.”, including Chapter N “Quality Control and Quality Assurance”.
   3. RCSC’s “Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.”

F. Quality Control Inspector Qualifications:
   1. Quality control (QC) welding inspection personnel shall be qualified to the satisfaction of the fabricator’s or erector’s QC program, as applicable, and in accordance with either of the following:
      a. Associate welding inspectors (AWI) or higher as defined in AWS B5.1, Standard for the Qualification of Welding Inspectors, or
      b. Qualified under the provisions of AWS D1.1/D1.1M sub clause 6.1.4
   2. QC bolting inspection personnel shall be qualified on the basis of documented training and experience in structural bolting inspection.

G. The fabricator and erector shall establish and maintain quality control procedures and perform inspections to ensure that their work is performed in accordance with this Specification and the construction documents.

1.9 QUALITY ASSURANCE

A. All load-bearing structural steel shall be fabricated and produced using only steel made in the United States in accordance with Sections 153.011 and 153.99 of the Ohio Revised Code (ORC).

B. Quality assurance (QA) as specified in this section shall be provided by the Qualified Testing Agency.

C. Quality Assurance Inspector Qualifications
   1. Quality assurance (QA) welding inspectors shall be qualified to the satisfaction of the QA agency’s written practice, and in accordance with either of the following:
      a. Welding inspectors (WIs) or senior welding inspectors (SWIs), as defined in AWS B5.1, Standard for the Qualification of Welding Inspectors, except associate welding inspectors (AWIs) are permitted to be used under the direct supervision of WIs, who are on the premises and available when weld inspection is being conducted, or
      b. Qualified under the provisions of AWS D1.1/D1.1M, sub clause 6.1.4
   2. QA bolting inspection personnel shall be qualified on the basis of documented training and experience in structural bolting inspection.

D. NDT Personnel Qualifications
   1. Nondestructive testing personnel, for NDT other than visual, shall be qualified in accordance with their employer’s written practice, which shall meet or exceed the criteria of AWS D1.1/D1.1M Structural Welding Code—Steel, sub clause 6.14.6, and:
a. American Society for Nondestructive Testing (ASNT) SNT-TC-1A, Recommended Practice for the Qualification and Certification of Nondestructive Testing Personnel, or
b. ASNT CP-189, Standard for the Qualification and Certification of Nondestructive Testing Personnel

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated and AISC 360.
   2. Use Allowable Stress Design; data are given at service-load level.

2.2 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
   1. W-Shapes: 60 percent.
   2. Channels, Angles: 60 percent.
   3. Plate and Bar: 25 percent.
   4. Cold-Formed Hollow Structural Sections: 25 percent.
   5. Steel Pipe: 25 percent.
6. All Other Steel Materials: 25 percent.


C. Channels, Angles, M-Shapes: ASTM A36 or ASTM A572, Grade 50.

D. Plate and Bar: ASTM A36.

E. Hollow Structural Sections: ASTM A1085, structural tubing.

F. Steel Pipe: ASTM A53, Type E or Type S, Grade B.

G. Welding Electrodes:
   1. Use E70XX electrode unless noted otherwise.
   2. Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Use as default bolt unless noted otherwise.
   2. Finish: Plain.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

C. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

D. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
   1. Finish: Hot-dip or mechanically deposited zinc coating.
   2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.

E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
F. Unheaded Anchor Rods: ASTM F 1554, Grade 36, U.N.O.
   4. Washers: ASTM F 436, Type 1, hardened carbon steel.
   5. Finish: Plain.

G. Threaded Rods: ASTM A 36.
   2. Washers: ASTM F 436, Type 1, hardened carbon steel.
   3. Finish: Plain.


I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.


2.4 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Primer: Zinc oxide, oil. Lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
   1. Coordinate primers with topcoats, requirements for slip critical joints, and limitations of sprayed fire resistive materials.

C. Galvanizing Repair Paint: MPI#18, MPI#19, ASTM A780, or SSPC-Paint 20.

2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 BITUMINOUS COATING

A. Cold applied asphalt mastic.
2.7 FABRICATION


1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Install headed studs on all structural steel beams supporting Concrete Masonry Units directly on the beam's top flange.

H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

I. Closure Plates: Provide minimum 1/4 inch closure plates at all Hollow Structural Steel tube ends, U.N.O. on plans.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Pretensioned.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.9 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
      a. Apply a bituminous coating to steel embedded in concrete or mortar.
   2. Surfaces to be field welded.
   4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."
   2. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.10 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123.
   1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
   2. Galvanize lintels, shelf angles, relief angles and welded door frames attached to structural-steel frame and located in exterior walls.
   3. Galvanize all exterior exposed steel including unwrapped canopy columns, steel projecting above the roof line, and exterior mechanical supports.
2.11 SOURCE QUALITY CONTROL

A. Material identification procedures shall comply with the requirements of Section 6.1 of the Code of Standard Practice, and shall be monitored by the fabricator’s quality control inspector (QCI).

B. Bolted Connections: Inspect and test shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: In addition to visual inspection, shop-welded connections will be tested according to AWS D1.1 and the following inspection procedures:
   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   4. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
   1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Tests will be conducted according to requirements in AWS D1.1 on additional shear connectors if weld fracture occurs on shear connectors already tested.

E. Other Inspection Tasks
   1. The fabricator’s QCI shall inspect the fabricated steel to verify compliance with the details shown on the shop drawings, such as proper application of joint details at each connection.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.3 COORDINATION

A. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

3.4 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303-10 and ANSI/AISC 360-10.

B. Erect structural steel in compliance with OSHA safety practices for steel erection per Federal Register 29 CFR 1926, Subpart R.

   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of baseplate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

E. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

F. Splice members only where indicated.
G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.5 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.


3. Remove backing bars exposed to view, back gouge, and grind welds smooth.

3.6 FIELD QUALITY CONTROL AND QUALITY ASSURANCE

A. Inspection: Owner will engage a qualified testing agency to perform the following inspections:

B. Inspection of Welding

1. Observation of welding operations and visual inspection of in-process and completed welds shall be the primary method to confirm that the materials, procedures and workmanship are in conformance with the construction documents. For structural steel, all provisions of AWS D1.1/D1.1M Structural Welding Code—Steel for statically loaded structures shall apply.

C. Inspection Tasks Prior to Welding

1. Welding procedure specifications (WPSs) available

2. Manufacturer certifications for welding consumables available

3. Material identification (type/grade)

4. Welder identification system

   a. The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.

5. Fit-up of groove welds (including joint geometry)

   a. Joint preparation
b. Dimensions (alignment, root opening, root face, bevel)
c. Cleanliness (condition of steel surfaces)
d. Tacking (tack weld quality and location)
e. Backing type and fit (if applicable)

6. Configuration and finish of access holes

7. Fit-up of fillet welds
   a. Dimensions (alignment, gaps at root)
   b. Cleanliness (condition of steel surfaces)
   c. Tacking (tack weld quality and location)

8. Check welding equipment

D. Inspection Tasks During Welding

1. Use of qualified welders

2. Control and handling of welding consumables
   a. Packaging
   b. Exposure control

3. No welding over cracked tack welds

4. Environmental conditions
   a. Wind speed within limits
   b. Precipitation and temperature

5. WPS followed
   a. Settings on welding equipment
   b. Travel speed
   c. Selected welding materials
   d. Shielding gas type/flow rate
   e. Preheat applied
   f. Interpass temperature maintained (min./max.)
   g. Proper position (F, V, H, OH)

6. Welding techniques
   a. Interpass and final cleaning
   b. Each pass within profile limitations
   c. Each pass meets quality requirements

E. Inspection Tasks After Welding

1. Welds cleaned

2. Size, length and location of welds

3. Welds meet visual acceptance criteria
   a. Crack prohibition
   b. Weld/base-metal fusion
   c. Crater cross section
   d. Weld profiles
   e. Weld size
   f. Undercut
   g. Porosity

4. Arc strikes

5. k-area
   a. When welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks within 3 inches of the weld.

6. Backing removed and weld tabs removed (if required)
7. Repair activities
8. Document acceptance or rejection of welded joint or member

F. Nondestructive Testing of Welded Joints

1. Procedures
   a. Ultrasonic testing (UT), magnetic particle testing (MT), penetrant testing (PT) and radiographic testing (RT), where required, shall be performed by QA in accordance with AWS D1.1/D1.1M. Acceptance criteria shall be in accordance with AWS D1.1/D1.1M for statically loaded structures, unless otherwise designated in the design drawings or project specifications.

2. CJP Groove Weld NDT
   a. UT shall be performed by QA on 10% of CJP groove welds in butt, T- and corner joints subject to transversely applied tension loading, in materials 5/16 inch thick or greater.

3. Access Hole NDT
   a. Thermally cut surfaces of access holes shall be tested by QA using MT or PT, when the flange thickness exceeds 2 inches for rolled shapes, or when the web thickness exceeds 2 inches for built-up shapes. Any crack shall be deemed unacceptable regardless of size or location.

4. Welded Joints Subjected to Fatigue
   a. Welded joints in the following members require weld soundness to be established by radiographic or ultrasonic inspection and shall be tested by QA as prescribed. Reduction in the rate of UT is prohibited:
      1) Flagpoles / Sign Posts
      2) Equipment Support Bases
      3) Elevator machine beams
      4) Monorails / Conveyors

5. Reduction of Rate of Ultrasonic Testing
   a. The rate of UT is permitted to be reduced if approved by the EOR and the AHJ.
   b. Where the initial rate for UT is 100%, the NDT rate for an individual welder or welding operator is permitted to be reduced to 25%, provided the reject rate, the number of welds containing unacceptable defects divided by the number of welds completed, is demonstrated to be 5% or less of the welds tested for the welder or welding operator.
   c. A sampling of at least 40 completed welds for a job shall be made for such reduction evaluation.
      1) For evaluating the reject rate of continuous welds over 3 feet in length where the effective throat is 1 inch or less, each 12 inch increment or fraction thereof shall be considered as one weld.
      2) For evaluating the reject rate on continuous welds over 3 feet in length where the effective throat is greater than 1 inch, each 6 inches of length or fraction thereof shall be considered one weld.

6. Increase in Rate of Ultrasonic Testing
   a. Where the initial rate for UT is 10%, the NDT rate for an individual welder or welding operator shall be increased to 100% should the reject rate, the number of welds containing unacceptable defects divided by the number of welds completed, exceeds 5% of the welds tested for the welder or welding operator.
   b. A sampling of at least 20 completed welds for a job shall be made prior to implementing such an increase.
c. When the reject rate for the welder or welding operator, after a sampling of at least 40 completed welds, has fallen to 5% or less, the rate of UT shall be returned to 10%.

1) For evaluating the reject rate of continuous welds over 3 ft in length where the effective throat is 1 in. or less, each 12-inch increment or fraction thereof shall be considered as one weld.

2) For evaluating the reject rate on continuous welds over 3 feet in length where the effective throat is greater than 1 inch., each 6 inches of length or fraction thereof shall be considered one weld.

7. Documentation
   a. All NDT performed shall be documented.
   b. For shop fabrication, the NDT report shall identify the tested weld by piece mark and location in the piece.
   c. For field work, the NDT report shall identify the tested weld by location in the structure, piece mark, and location in the piece. When a weld is rejected on the basis of NDT, the NDT record shall indicate the location of the defect and the basis of rejection.

G. Inspection of High-Strength Bolting
   1. Observation of bolting operations shall be the primary method used to confirm that the materials, procedures and workmanship incorporated in construction are in conformance with the construction documents and the provisions of the RCSC Specification.
      a. For snug-tight joints, pre-installation verification testing and monitoring of the installation procedures, as specified below, are not applicable. The QAI need not be present during the installation of fasteners in snug-tight joints.
   2. For pretensioned joints and slip-critical joints, when the installer is using the turn-of-nut method with matchmarking techniques, the direct-tension-indicator method, or the twist-off-type tension control bolt method, monitoring of bolt pretensioning procedures shall be as specified below. The QAI need not be present during the installation of fasteners when these methods are used by the installer.
   3. For pretensioned joints and slip-critical joints, when the installer is using the calibrated wrench method or the turn-of-nut method without matchmarking, monitoring of bolt pretensioning procedures shall be as specified below. The QCI and QAI shall be engaged in their assigned inspection duties during installation of fasteners when these methods are used by the installer.
   4. As a minimum, bolting inspection tasks shall be in accordance with the tasks listed below.

H. Inspection Tasks Prior to Bolting
   1. Manufacturer’s certifications available for fastener materials
   2. Fasteners marked in accordance with ASTM requirements
   3. Proper fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane)
   4. Proper bolting procedure selected for joint detail
   5. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements
   6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used
   7. Proper storage provided for bolts, nuts, washers and other fastener components
I. Inspection Tasks During Bolting
1. Fastener assemblies, of suitable condition, placed in all holes and washers (if required) are positioned as required.
2. Joint brought to the snug-tight condition prior to the pretensioning operation.
3. Fastener component not turned by the wrench prevented from rotating.
4. Fasteners are pretensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges.

J. Inspection Tasks After Bolting
1. Document acceptance or rejection of bolted connections.

K. Other Inspection Tasks
1. The fabricator’s QCI shall inspect the fabricated steel to verify compliance with the details shown on the shop drawings, such as proper application of joint details at each connection.
2. The erector’s QCI shall inspect the erected steel frame to verify compliance with the details shown on the erection drawings, such as braces, stiffeners, member locations and proper application of joint details at each connection.
3. The QAI shall be on the premises for inspection during the placement of anchor rods and other embedments supporting structural steel for compliance with the construction documents.
   a. As a minimum, the diameter, grade, type and length of the anchor rod or embedded item, and the extent or depth of embedment into the concrete, shall be verified prior to placement of concrete.
4. The QAI shall inspect the fabricated steel or erected steel frame, as appropriate, to verify compliance with the details shown on the construction documents, such as braces, stiffeners, member locations and proper application of joint details at each connection.

L. NONCONFORMING MATERIAL AND WORKMANSHIP
1. Identification and rejection of material or workmanship that is not in conformance with the construction documents shall be permitted at any time during the progress of the work. However, this provision shall not relieve the owner or the inspector of the obligation for timely, in-sequence inspections.
2. Nonconforming material and workmanship shall be brought to the immediate attention of the fabricator or erector, as applicable.
3. Nonconforming material or workmanship shall be brought into conformance, or made suitable for its intended purpose as determined by the engineer of record.
4. Concurrent with the submittal of such reports to the AHJ, EOR or owner, the QA agency shall submit to the fabricator and erector:
   a. Nonconformance reports
   b. Reports of repair, replacement or acceptance of nonconforming items

3.7 REPAIRS AND PROTECTION
A. Bituminous Coatings: Apply a bituminous coating to steel embedded in concrete or mortar.
B. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
C. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION 051200
SECTION 052100 - STEEL JOIST FRAMING

PART 1 - GENERAL
When the information in this Specification Section conflicts with information on the Structural Construction Drawings, the Structural Construction Drawings shall prevail.

1.1 SUMMARY

A. Section Includes:
   3. LH-series long-span steel joists.

B. Related Requirements:
   1. Section 042200 “Concrete Unit Masonry” for installing bearing plates in unit masonry.

1.2 DEFINITIONS

A. Add-Load: A single vertical concentrated load which occurs at any one panel point along the joist chord. This load is in addition to any other gravity loads specified.

B. Bend-Check Load: A vertical concentrated load used to design the joist chord for the additional bending stresses resulting from this load being applied at any location between the joist panel points. This load shall already be accounted for in the specified joist designation load, uniform load, or Add-load and is used only for the additional bending check in the chord and does not contribute to the overall axial forces within the joist.


D. Contractor: Owner of a Building, or the person who contracts with the Owner, who constructs the Building in accordance with the Construction Documents and the Steel Joist Submittal Package. The term “Contractor” shall include those subcontractors who have a direct contract with the Contractor to construct all or a portion of the construction.

E. Framing Structural System: Completed combination of Structural Elements, joists, connections and other systems, which serve to support the Building's self-weight and the specified loads.

F. Joist Design Engineer: Person who is licensed to practice engineering in the State of Ohio and who supervises the preparation of the joist shop drawings.
G. Joist Installer: The Contractor, or subcontractor, responsible for the safe lifting/hoisting and installation of the joists, including the installation of all temporary and permanent restraints and bracing.

H. K- and LH- series steel joists: Open web, load-carrying members utilizing hot-rolled or cold-formed steel, including cold-formed steel whose yield strength has been attained by cold working, suitable for the direct support or floors and roof slabs or deck.

I. Placement Plans. Drawings that are prepared depicting the interpretation of the contract documents requirements for the material to be supplied by the joist manufacturer. A unique piece mark number shall be shown for the individual placement of the steel joists and accessories along with sections that describe the end bearing conditions and minimum attachment required so that material is placed in the proper location in the field.

J. SJI's “Specifications”: Steel Joist Institute's “Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.”

K. Special Joists: Steel joists requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's “Specifications.” These joists are noted on plan with an “SP” notation.

1.3 REFERENCES
A. Steel Joist Institute (SJI)

1.4 ACTION SUBMITTALS
A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings (Placement Plans): Show fabrication and installation details for joists as outlined below. Joist manufacturer shall not modify the joist layout shown on the Structural Construction Documents without first consulting with and getting approval from the RDP. Any modification requests shall be made during the bidding period or may be subject to additional engineering fees if submitted during the shop drawing review process.

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.
4. Details shall be specific to the Project's requirements
5. Steel joist placement plans do not require the seal and signature of the Joist Design Engineer
C. Joist Manufacturer shall submit the Shop Drawings to the Registered Design Professional for review and approval prior to the manufacturing of joists.

D. One (1) hardcopy and one (1) electronic copy (in PDF format) for the structural steel joist shop drawings shall be submitted for review. The hardcopy of the structural steel joist shop drawings will be redmarked by SMA. One (1) redmarked hardcopy will be retained by SMA as an office copy. One (1) electronic copy of this redmarked set will be submitted as the approved set. No allowance has been made for redmarking a quantity of hardcopies greater than that noted above. Fees for in-house duplication of redmarks on printed hardcopies may be an Additional Service and invoiced at an hourly rate using Shell + Meyer’s Standard Rate Schedule.

E. The fee to use Shell + Meyer's drawings to develop structural shop drawings is $50.00 per sheet requested. The fee is charged directly to the sub-contractor who requests the files.

F. Submittals requiring more than TWO (2) reviews by SMA resulting from errors and omissions of the supplier's detailer will be an Additional Service and invoiced at an hourly rate. An invoice for these services will be attached to the final approved set of shop drawings.

G. The Contractor shall ensure the Joist Manufacturer has the latest issue of the Contract Documents, including but not limited to Structural Drawings, Addendums, Bulletins, and Specifications.

H. The Contractor shall ensure that dimensional field modifications of the supporting structure are conveyed to the joist manufacturer prior to the joist installation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer certificates.

C. Comprehensive engineering analysis of Special Joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's “Specifications.”

   1. Manufacturer's responsibilities include providing professional engineering services for designing Special Joists to comply with performance requirements and for those items listed under the 'Delegated Design Submittal' of this Specification.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1, “Structural Welding Code - Steel.”
1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's “Specifications.”

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

A. Deliver steel bearing plates to be built into masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Joist manufacturer shall design joists for additional loads at locations shown on the Structural Drawings.

B. Delegated-Design Submittal:
   1. For Special Joists indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the Joist Design Engineer responsible for their preparation. The qualified professional engineer shall be licensed in the State of Ohio.

C. Structural Performance: Provide Special Joists and connections capable of withstanding design loads indicated.
   1. Use ASD; data are given at service-load level.
   2. Refer to structural notes on the Structural Drawings for net uplift forces for the design of joists and/or bridging.
      a. If net uplift pressure is not indicated, use minimum 15 PSF
   3. Snow Drift Loads: Unless otherwise noted as an 'SP' joist, the steel joist design includes the drift loads noted on the Structural Plans.
   4. Mechanical units
   5. Axial loads:
      a. Refer to plans for axial loads need to be incorporated into the joist design at Drag Strut locations.
   6. Moments: No additional moments need to be incorporated into the joist design.
   7. Structural bracing loads: See sections for additional bracing loads.
   8. Joist extensions supporting brick loads indicated.
      a. Joist extensions shall be reinforced to maintain a 2-1/2 inch joist shoe depth.
   9. The following “Bend-Check” Load
      a. Except as noted below, design for additional bending stresses resulting from a 250 lb. concentrated load located at any location along both top and bottom chord.
b. Design for additional bending stresses resulting from a 700 lb. concentrated load located at any location along both top and bottom chord at 'KCS' series roof and floor joists located over corridors to support MEP pipe loads (hanger loads shall be staggered on joists)

10. Design Special Joists to withstand design loads with load deflections no greater than the following:

   c. Roof Joists (Special Gable Profile):
      1) Maximum Vertical Live Load Deflection = 1/300 of the span
      2) Maximum Vertical Total Load Deflection = 1/240 of the span

D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 K-SERIES STEEL JOISTS

A. Manufacture steel joists of type indicated according to “Standard Specifications for Open Web Steel Joists, K-Series” in SJI's “Specifications,” with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

   1. Joist End Bearing Depth = 2 1/2 inches, except as noted below.
      a. Sloped joists;
      b. Mixing K-Series and LH-Series products at a common interior support;
      c. Masonry supports with a steel bearing plate more than 1/2 inch from the face of the wall.

B. Top chord angles shall be fabricated only from structural steel conforming to the following materials listed in Section 3.1 of SJI Standard Specification for Open Web Steel, K-Series (SJI-K-2010):

   1. ASTM A36
   2. ASTM A572
   3. ASTM A992

C. Top chord angles shall have a minimum horizontal leg width of 2 inches at locations where a dovetail roof deck bears on the top chord.

D. Steel Joist Substitutes: Manufacture according to “Standard Specifications for Open Web Steel Joists, K-Series” in SJI's “Specifications,” with steel-angle or -channel members.

E. Provide holes in chord members for connecting and securing other construction to joists.

F. Top-Chord Extensions: Extend top chords of joists with SJI's Type R top-chord extensions where indicated, complying with SJI's “Specifications.”

G. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's “Specifications.”
H. Camber K-series steel joists according to SJI's “Specifications.”  (Table 4.6-1)

I. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.3 LONG-SPAN STEEL JOISTS

A. Manufacture steel joists according to “Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series” in SJI's “Specifications,” with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as indicated.

1. Joist End Bearing Depth = 5 inches
2. End Arrangement: Underslung.
3. Top-Chord Arrangement: Parallel

B. Top chord angles shall be fabricated only from structural steel conforming to the following materials listed in Section 102.1 of SJI Standard Specification for Longspan Steel Joists, LH-Series Joists (SJI-LH-2010):

1. ASTM A36
2. ASTM A572
3. ASTM A992

C. Provide holes in chord members for connecting and securing other construction to joists.

D. Camber long-span steel joists according to SJI's “Specifications.”  (Table 103.6-1)

E. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.4 PRIMERS

A. Low-Emitting Materials: Paints and coatings 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. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.5 JOIST ACCESSORIES

A. Bridging: Schematically indicated. Detail and fabricate according to SJI's “Specifications.” Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A 36 steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint.
C. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction and partition loads indicated. Extend ends to within 1/2 inch of finished wall surface unless otherwise indicated.

D. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
   1. Finish: Plain, uncoated.

E. Welding Electrodes: Comply with AWS standards.

F. Headers: Headers for Open Web Steel Joists, K-Series shall be furnished by the Joist Manufacturer. Such headers shall be any type standard with the Manufacturer.

G. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.6 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's “Specifications”, the joist manufacturer's written recommendations, and requirements in this Section.

   1. Before installation, splice joists delivered to Project site in more than one piece.
   2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. When required, only provide welds parallel to the joist chords. Do not weld across joist chords without written authorization from the Joist Designer and the Registered Design Professional.

E. Bolt joists to supporting steel framework using carbon-steel bolts if required to meet OSHA requirements.

F. Bridging (General)
   1. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.
   2. Bridging shall support the top and bottom chords against lateral movement during the construction period and shall hold the steel joists in the approximate position as shown on the joist placement plans.
   3. A single line of bottom chord bridging (Uplift Bridging) shall be provided near the first bottom chord panel points of all roof joists.
   4. The ends of all bridging lines terminating at walls or beams shall be anchored thereto.
      a. A bridging terminus point shall be established before joist bridging is installed.
      b. When permanent bridging terminus points cannot be used during erection, additional temporary bridging terminus points are required to provide stability.

G. Bridging (Diagonal)
   1. When bolted diagonal erection bridging is required, the following shall apply:
      a. The bridging shall be indicated on the joist placement plan.
      b. The joist placement plan shall be the exclusive indicator for the proper placement of this bridging.
      c. Shop installed bridging clips, or functional equivalents, shall be provided where the bridging bolts to the steel joist.
      d. When two pieces of bridging are attached to the steel joist by a common bolt, the nut that secures the first piece of bridging shall not be removed from the bolt for the attachment of the second piece.
      e. Bridging attachments shall not protrude above the top chord of the steel joists.

H. Bearing Seat Attachments
   1. Ends of K-Series Joists resting on steel bearing plates on masonry or structural concrete shall be attached thereto with a minimum of two 1/8 inch fillet welds 2 inches long.
   2. Ends of K-Series Joists resting on steel supports shall be attached thereto with a minimum of two 1/8 inch fillet welds 2 inches long.
   3. Weld LH-series joists according to SJI's "Specifications" TABLE 104.7-1.

I. Construction Loading
   1. No Construction Loads shall be allowed on the steel joists until all bridging is installed and anchored, and all joist bearing ends are attached.
2. During the construction period, loads placed on the steel joists shall be distributed so as not to exceed the capacity of the steel joists.

3. No bundle of deck shall be placed on steel joists until all bridging has been installed and anchored and all joist bearing ends attached, unless the following conditions are met:
   a. The contractor has first determined from a qualified person, as defined by OSHA, and documented in a site-specific erection plan that the structure or portion of the structure is capable of supporting the load;
   b. The bundle of decking is placed on a minimum of 3 steel joists;
   c. The joists supporting the bundle of decking are attached at both ends;
   d. At least one row of bridging is installed and anchored;
   e. The total weight of the decking does not exceed 4000 pounds; and
   f. The edge of the decking shall be placed within 1 foot of the bearing surface of the joist end.

4. The edge of the construction load shall be placed within 1 foot of the bearing surface of the joist end.

J. Concentrated Loads
   1. Where concentrated loads greater than 100 pounds do not occur at panel points, an extra web shall be field applied from the point of attachment to a panel point on the opposite chord

K. Fall Arrest System Support
   1. Steel joists shall not be used as anchorage points for a fall arrest system unless written directions to do so is obtained from a “qualified person”, as defined by OSHA.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

B. Visually inspect field welds according to AWS D1.1/D1.1M.

C. Visually inspect bolted connections.

D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

E. Perform additional testing to determine compliance of corrected Work with specified requirements.

3.4 PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer’s written instructions.
B. Touchup Painting: After installation, promptly clean, prepare, and prime or re Prime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.

1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2, or power-tool cleaning according to SSPC-SP 3.
2. Apply a compatible primer of same type as primer used on adjacent surfaces.

C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 052100
SECTION 053100 - STEEL DECKING

PART 1 - GENERAL
When the information in this Specification Section conflicts with information on the Structural Construction Drawings, the Structural Construction Drawings shall prevail.

1.1 SUMMARY
A. Section Includes:
   1. The extent of steel deck shown on the Drawings including type of deck, layout and orientation.
   2. Welds and mechanical fastener types, sizes and patterns.

1.2 DEFINITIONS
A. Terms not defined in this Specification, AISI S100 or AISI/AISC shall have the ordinary accepted meaning for the context for which they are intended.
B. Base Material – The existing part of the work that is a base for the fastening. The structural steel or bar joist framing members in steel deck applications
C. Button Punch – A mechanical means of connecting two pieces of sheet metal together by crimping with a special tool. Unless noted otherwise, button punching shall not be permitted.
D. Diaphragm Deck – A decking system which is designed to carry lateral loads due to wind or seismic action in addition to gravity loads and wind uplift.
E. Endlap – The overlap of adjacent steel deck panels at the ends of the panels (end edges perpendicular to the steel deck fluting).
F. Fastener Pattern – The number and spacing of fasteners at each support for a steel deck panel.
G. Interlocking Sidelap (BI Connection) – Steel deck panels having male and female side edges. The adjacent deck panel male and female edges interlock into each other when the deck is installed. The interlocks are fastened together using button punches, proprietary punch systems, welds, or screws. Unless noted otherwise, interlocking sidelaps shall not be permitted.
H. Nestable Sidelap – Steel deck type in which the side edge of the steel deck panel contains a partial valley profile and overlaps, or "nests" on top of the side edge of the adjacent steel deck panel, which contains a full valley profile.
I. Pullout – As related to fasteners, a failure mode that occurs when the fastener pulls out of the base steel support
J. Pullover – As related to fasteners, a failure mode that occurs when the steel deck panel pulls over the fastener head or washer(s).
K. Sidelap – The side edge overlap of adjacent steel panels (side edges parallel to the steel deck panel fluting).

L. Tack Weld – A weld of no structural significance. Used for temporary attachment of steel to the supporting frame. A weld made to hold the parts in proper alignment until the final welds are made.

M. Uplift – Vertical load on the steel deck panels due to wind forces

1.3 REFERENCES

A. American Concrete Institute
   1. ACI 318-11, Building Code Requirements for Structural Concrete

B. American Society for Testing and Materials (ASTM):
   1. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
   2. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   4. ASTM C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

C. American Institute of Steel and Iron (AISI):
   1. AISI S100-07 w/S2-10, North American Specification for the Design of Cold-Formed Steel Structural Members, Including Supplement 2 (February 2010)
   2. AISI S905-08, Test Methods for Mechanically Fastened Cold-Formed Steel Connections
   3. AISI S907-08, Test Standard for Cantilever Test Method for Cold Formed Steel Diaphragms

D. American National Standards Institute (ANSI)
   1. Safety Requirements for Powder-Actuated Fastening Systems (ANSI A10.3)

E. American Welding Society (AWS):
   1. Structural Welding Code – Steel (D1.1)
   2. Structural Welding Code – Sheet Steel (D1.3-2008)

   1. Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43)
   2. Steel Deck Diaphragms Attached with Hilti X-HSN 24 or X-ENP-19 L15 Power-Driven Fasteners and Hilti S-SLC 01 M HWH and S-SLC 02 M HWH Sidelap Connectors (ESR-2776)
   3. Bare Steel Deck and Concrete-Filled Steel Deck Diaphragms Attached with Hilti X-ENP-19 L15 or X-HSN 24 Fasteners (ESR-2197)

G. Steel Deck Institute (SDI):
2. "Standard for Steel Roof Deck" RD-2010
3. "Standard for Non-Composite Steel Floor Deck" NC-2010
9. "Standard for Quality Control and Quality Assurance for the Installation of Steel Deck", as modified by Table C-1 contained in the Commentary to that Standard, QA/QC – 2011
11. Deck Damage and Penetrations, DDP – 2000

H. Underwriters Laboratories (UL):
   1. Roofing Materials and Systems Directory
   2. Fire Resistance Directory, Volume 1

I. Wire Reinforcement Institute (WRI):

1.4 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:
   1. Deck layout and orientation, supporting steel framing and supports with dimensions and section details.
   2. Deck type and profile, dimensions, supports, projections, and cut deck openings.
   3. Reinforcing channels, pans, special jointing, accessories, and attachments to other construction.
   4. Welds and mechanical fastener types, sizes and patterns.
   5. Sidelap connector types, sizes and patterns.
   6. Accessory details

1.5 INFORMATIONAL SUBMITTALS

A. The following documents shall be made available in electronic form to the Designer for review prior to installation of the deck
   1. Manufacturer’s Published Installation Instructions and product data sheets, catalogue data, or independent evaluation reports (ICC-ESR) for mechanical fasteners
   2. Product Certificates: For each type of steel deck.
   3. Manufacturer’s data for welding consumables
   4. Manufacturer’s product data sheets or catalog data for welding filler metals and fluxes to be used. The data sheets shall describe the product, limitations of use, recommended or typical welding parameters, and storage and exposure requirements, including baking, if applicable.
   5. Welding Procedure Specifications (WPS)
6. Procedure Qualification Records (PQR) for WPS that are not prequalified in accordance with AWS D1.1 or AWS D1.3, as applicable.
7. Welding Personnel Performance Qualification Records (WPQR)
8. Installer’s Quality Control Program (QCP)
9. Installer’s QC Inspector qualifications
10. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Quality Control and Quality Assurance for steel deck installation shall be in accordance with SDI QA/QC 2011, "Standard for Quality Control and Quality Assurance for the Installation of Steel Deck", as modified by Table C-1 contained in the Commentary to that Standard.

B. Manufacturer Qualifications:
   1. Steel Roof Deck Manufacturer: Member producer of SDI.
   2. Mechanical Fastener Manufacturer: Member producer of SDI and ISO 9001 accredited for manufacturing quality control.

C. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

D. Welding Qualifications: All steel roof deck welders AWS certified for welding of sheet steel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

E. Mechanical Fastener Installers: All mechanical fastener installers certified or licensed by the fastener and tool system manufacturer on the project site in accordance with ANSI A10.3 requirements. Certification or licensing includes all training necessary for proper tool operation, fastener selection, maintenance and troubleshooting.

F. Comply with all manufacturer catalog and carton installation instructions, product data and technical bulletins.

G. Pre-Installation Meeting:
   1. Installer shall demonstrate workmanship by conducting representative fastenings and welds at pre-installation meeting subject to guidance from mechanical fastener manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Deck:
   1. Do not rack, bend or mar steel deck sheets.
   2. Store steel deck sheets and accessories above ground and protected from free weathering with one end elevated to provide drainage.
   3. Cover with waterproof covering and ventilate to avoid condensation until final installation.
   4. Architecturally exposed steel deck sheets shall be appropriately packaged or protected to prevent damage during delivery, storage and handling.

B. Welding Electrodes, Mechanical Fasteners, and Sidelap Connectors
1. Store welding electrodes, mechanical fasteners and powder-actuated cartridges in original packages in a cool, dry location until final installation.
2. Comply with all project and national safety regulations regarding handling of welding equipment and powder-actuated fastening systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. The steel roof deck is used as part of the horizontal bracing system and the fastening method and pattern have been selected to provide a certain strength and stiffness in the plane of the deck. NO SUBSTITUTION of fastener type or pattern shall be made without the approval of the Structural Engineer of Record.

C. Refer to Part 3, "Concrete Placement" Article of this Section for design construction live loads.

D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACCEPTABLE MANUFACTURERS

A. Steel Deck: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Epic Metals Corporation.
   3. New Millennium Building Systems, LLC.
   5. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Mechanical Fasteners

   1. Hilti, Inc.
   2. ITW Buildex (limited to use in base material of 0.0346 inches or less)
   3. Pneutek
   4. Other approved alternative

C. Sidelap Connectors

   1. Elco
   2. Hilti, Inc.
   3. ITW Buildex
   4. Other approved alternative
2.3 MATERIALS

A. Roof Deck (Non-Acoustic): Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33, G90 zinc coating with factory prime paint coat.
2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: Triple span or more.

B. Non-Composite Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33, G60 zinc coating.
2. Profile Depth: As indicated.
3. Design Uncoated-Steel Thickness: As indicated.
4. Span Condition: As indicated.

C. Welds and Mechanical Fasteners:

1. Welds:
   a. Material: Electric shielded arc process using minimum E60XX electrodes in accordance with AWS D1.3 procedures
   b. Weld Quality: All welds uniform size and appearance and free of pinholes, porosity, undercutting or other defects
   c. Weld Size: Minimum 5/8 in. effective diameter
   d. Weld Washers: Use on steel roof deck thinner than 22 gauge

2. Mechanical Fasteners:
   a. Material: AISI 1070 modified
   b. Hardness: Minimum Rockwell Hardness C 54.5
   c. Strength: Minimum tensile strength 285 ksi; minimum shear strength 175 ksi
   d. Design and Manufacture: Knurled shank with forged ballistic point. Manufacturing process shall ensure steel ductility and prevent development of hydrogen embrittlement.
   e. Washers:
      1) For steel bar joist framing: 0.472 inch steel washers
      2) For structural steel framing: Minimum 0.591 inch steel washers
   f. Corrosion Resistance:
      1) For steel roof decks with waterproofing membrane: 5 micron zinc electroplated in accordance with ASTM B 633 SC1 Type III
   g. Approved Types
      1) For use with steel bar joist and light structural steel framing supports with top chord or flange thickness 1/8 inch to 3/8 inch:
         a) Hilti X-HSN 24 (1/8 in. up to and including 3/8 in.)
         b) Other approved alternative
2) For use with structural steel framing supports with top flange thickness 1/4 inch or thicker:
   a) Hilti X-ENP-19 L15 (1/4 in. or thicker)
   b) Other approved alternative
3) For use with Cold Formed Steel Framing
   a) ITW Buildex TEKS Self Drilling Fasteners
   b) Other approved alternative

D. Sidelap Connectors
   1. Acceptable types of sidelap connectors:
      a. Mechanical sidelap connectors
         1) Drive mechanical sidelap connectors completely through adjacent lapped roof deck sheets to achieve positive engagement of adjacent sheets with a minimum of three thread penetration.
         2) Material: ASTM A 510 Grade 1022
         3) Hardness: Minimum Vickers Surface Hardness of 450 HV0.3
         4) Design and Manufacture: Hex washer head undercut with reverse serrations; self-piercing or stitch point at center
         5) Approved Types
            a) Hilti S-SLC01 M HWH Sidelap Connector
            b) Hilti S-SLC02 M HWH Sidelap Connector
            c) ITW Buildex TEKS Self Drilling Fasteners
            d) Other approved alternative
      b. Button punches shall not be used unless specifically noted

2.4 TOLERANCES
   A. The minimum uncoated steel thickness as delivered to the job site shall not at any location be less than 95% of the design thickness, however lesser thicknesses shall be permitted at bends, such as corners, due to cold-forming effects.
   B. Panel length shall be no less than 1/2 inch shorter than the specified length nor greater than 1/2 inch longer than the specified length for single span. Panel length shall be no less than 1/2 inch shorter than the specified length for lapped end deck.
   C. Panel cover width shall be no less than 3/8 inch less than the specified panel width, nor more than 3/4 inch greater than the specified width.
   D. Panel camber and/or sweep shall not be greater than 1/4 inch in a 10 foot length
   E. Panel end out of square shall not exceed 1/8 inch per foot of panel width.

2.5 ACCESSORIES
   A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
   B. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
C. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

D. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth, unless otherwise noted on the drawings.

E. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

F. Piercing Hanger Tabs: NOT PERMITTED

G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.056 inch thick, with factory-punched hole of 3/8-inch minimum diameter (for weld-fastening deck with an uncoated minimum steel thickness of less than 0.028 inch).

H. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

I. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

J. Galvanizing Repair Paint: ASTM A 780.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Confirm location and elevation of supporting steel framing with the Drawings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Layout: Place steel roof deck sheets as shown on the Drawings ensuring bearing on supporting steel framing. Sheets shall be true and straight with horizontal deviations less than 1/4 in. in 100 feet.

B. Marking: Mark steel roof deck at the centerline of supporting steel members to prevent weld burn through or mechanical fastener punch through. Use a chalk line or indelible marker.

C. Test Fastenings:
1. **Welds:** Perform project specific test welds prior to final installation per AWS D1.3. Test welds are considered examples of representative work.

2. **Mechanical fasteners:** Gauge powder-actuated tool systems to the base material steel type, steel deck type and thickness prior to final installation. Confirm appropriate power regulation and powder-actuated cartridge type prior to final installation.

### 3.3 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Locate deck bundles to prevent overloading of supporting members.
   1. Deck bundles must always be placed on the steel frame near a main supporting beam at a column or wall. In no case shall the bundles be placed on unbolted frames or unattached or unbridged joists.
   2. The structural frame must be properly braced to receive bundles

C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened.

D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

H. All OSHA, State, and Local rules for erection shall be followed.

### 3.4 MECHANICAL FASTENERS

A. Fasteners shall not be installed into structural supports which are outside the acceptable limits of the manufacturers applicable test report or other documentation.

B. Fastener edge distance shall be as required by the applicable fastener design standard or manufacturer’s instructions.

C. When the structural support thickness is less than 1/8 inch, powder actuated or pneumatically driven fasteners shall not be used unless lesser support thicknesses are permitted by applicable fastener test report or other documentation acceptable to Shell and Meyer.

D. Screws shall have a grip range compatible with the combined thickness of the deck and supporting member.
3.5 ROOF DECK INSTALLATION

A. Install steel roof deck and accessories in accordance with manufacturer’s instructions and as shown on the Drawings.

B. Secure steel roof deck to supporting steel framing, collectors, drag members, and perimeter members with arc spot welds, fillet welds or mechanical fasteners as indicated. Install welds or mechanical fasteners at the spacing and pattern as shown on the Drawings. Anchorage shall provide temporary lateral stability to the top flange of the supporting structural members.

C. Deck shall be anchored to resist the required net uplift forces as noted on the Construction Drawings, but not less than the following:
   1. 45 pounds per square foot for eave overhang.
   2. 30 pounds per square foot for all other roof areas.

D. Secure steel roof deck sidelap connectors at the spacing and pattern as shown on the Drawings.

E. Unless otherwise noted on the Construction Drawings the following minimum deck attachments shall apply:
   1. **Deck to Supports:** Edge ribs of panels (the bottom flange of the last rib of a deck panel) shall be fastened to each point of support. Additional fasteners between edge ribs shall be spaced an average of 12 inches apart but not more than 18 inches, unless otherwise noted on the Construction Drawings.

2. **Connecting Sidelaps:** Side laps shall be fastened at intervals not to exceed 36 inches on center, using one of the following methods:
   a. Screws with a minimum diameter of 0.190 inches (#10 diameter)

3. **Perimeter Supports:** Perimeter edges of deck units between span supports shall be fastened at intervals not to exceed 12 inches on center, using one of the following methods:
   a. Screws with a minimum diameter of 0.210 inches (#12 diameter)
   b. Arc spot welds with a minimum 5/8 inch minimum visible diameter.
   c. Powder actuated or pneumatically driven fasteners.

F. **Cantilevers:**
   1. Side laps shall be attached at the end of the cantilever and at a maximum spacing of 12 inches on center from the cantilever end at each support.
   2. Each corrugation shall be fastened at both the perimeter support and the first interior support.
   3. The deck shall be completely attached to the supports and at the side laps before any load is applied to the cantilever.

G. Fastener edge distance shall be as required by the applicable fastener design standard.

H. **End Bearing:** Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
   1. **End Joints:** Lapped 2 inches minimum.

I. Deck bearing surfaces shall be permitted to deviate from parallel a maximum of 1:24, but not to exceed 1/16 inch.
1. Where deck bearing exceeds limits above, deck supplier shall provide continuous cold formed steel bent plate to match gauge of deck. Anchor to support with 1 1/2 inch fillet welds or mechanical fasteners at spacing to match support fasteners.

J. Miscellaneous Roof-Deck Accessories: Supply and install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Minimum thickness of accessories shall match deck thickness, unless otherwise noted.
2. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
3. Accessories shall be anchored to supporting members by arc spot welds or self drilling screws at 12 inches maximum intervals or as shown on the Construction Drawings.

3.6 ACCESSORY ATTACHMENT

A. Structural accessories shall be attached to supporting structure or deck as required for transfer of forces, but not to exceed 12 inches on center.

B. Non-structural accessories shall be attached to supporting structure or deck as required for serviceability, but not to exceed 12 inches on center.

3.7 REINFORCING STEEL

A. Unless noted otherwise, provide the following reinforcing
   1. Non-Composite Floor Deck –6X6 – W2.9XW2.9 WWR
   2. Composite Floor Deck –6X6 – W2.9XW2.9 WWR

B. Place reinforcement per the CRSI or WRI Manual of Standard Practice.

3.8 TEMPORARY SHORING

A. Temporary shoring, if required, shall be installed before placing deck panels and shall be designed to resist, at a minimum, the loading criteria indicated in ANSI/SDI C-2011 Section 2.4.A and ANSI/SDI C-2010, Section 2.4.A.

B. Design of shoring shall be a Delegated Design item provided by the Contractor.

C. Shoring shall be securely in place before floor deck erection begins.

D. Shoring shall be designed and installed in accordance with standards applicable to the specific shoring system and shall be left in place until the concrete attains 75% of its specified design strength, but not less than seven (7) days.
3.9 DECK DAMAGE AND PENETRATIONS

A. Round openings not shown on the erection drawings, such as those required for stacks, conduits, plumbing, vents, etc. shall be cut (and reinforced, if necessary) by the trades requiring the openings.
   1. A single opening of up to 6 inches in diameter may be placed in 1-1/2 inch steel roof deck.
      a. Spacing Perpendicular to Deck Flutes: Adjacent holes perpendicular to deck flutes must be placed at least 3 feet apart, or an angle frame will be required.
      b. Spacing Parallel to Deck Flutes: Adjacent holes parallel to deck flutes must be placed at least 12 inches apart as long as only one deck flute per sheet is being removed, or an angle frame will be required.
   2. Reinforce holes or dents in wide rib deck with a 20 inch square plate and attach to deck ribs with welds or screws at 8 inches on center maximum around the perimeter of the plate. Thickness of the plate shall be as follows:
      a. Up to 6 inches in diameter: No reinforcing required
      b. 6 inches to 8 inches in diameter: 0.045 inch minimum plate thickness
      c. 8 inches to 12 inches in diameter: 0.057 inch minimum plate thickness
      d. Over 12 inches: Frame opening
   3. Spacing of reinforced openings/dents shall be 36 inches on center minimum each way.
   4. Fasteners used around openings, both framed and reinforced, shall be the same type used to attach the deck to the frame. Spacing shall not exceed 8 inches on center around the opening.
   5. Openings or cut outs for Roof Sump Pans and Sump Plates shall comply with above reinforcing requirements.

B. Trades that subsequently cut unscheduled openings through the deck shall be responsible for reinforcing these openings based on an approved and sealed engineered design and submitted to Shell and Meyer Associates, Inc. for approval.
   1. Alternatively, the contractor can independently retain Shell + Meyer to provide additional design services required to determine the reinforcement requirements around the proposed opening.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Special Inspection of Deck Placement:
   1. Confirm minimum end bearing.
   2. Confirm bearing surface tolerances comply with SDI as noted in Executions article above

C. Special Inspection of Deck Welds:
   1. Examination and qualification of puddle and fillet welds shall be in accordance with AWS D1.3 criteria.
   2. Inspections Prior to Deck Placement
      a. Verify compliance of materials (deck and all deck accessories) with Construction Documents, including profiles, material properties, and base metal thickness
      b. Document acceptance or rejection of deck and deck accessories
   3. Inspections After Deck Placement
a. Verify compliance of deck and all deck accessories installation with Construction Documents
b. Document acceptance or rejection of installation of deck and deck accessories

4. Inspection Tasks Prior to Welding
   a. Welding Procedure Specifications (WPS) are available
   b. Manufacturer certifications for welding consumables are available
   c. Material identification (type and grade)
   d. Check welding equipment
e. Ensure steel roof deck is clamped to the supporting steel framing.

5. Inspection Tasks During Welding
   a. Use of qualified welders
   b. Control and handling of consumables
   c. Environmental conditions (wind speed, moisture, temperature)
   d. WPS followed
e. Weld metal shall penetrate all layers of deck material at end laps and shall have good fusion to the supporting members.

6. Inspection Tasks After Welding
   a. Verify size and location of welds, including support, sidelap, and perimeter welds
   b. Welds meet visual acceptance criteria
   c. Verify repair activities
d. Document acceptance or rejection of welds

D. Special Inspection of Mechanical Fasteners:
   1. Inspection Tasks Prior to Mechanical Fastening
      a. Manufacturer’s Published Installation Instructions (MPII) available for mechanical fasteners
      b. Proper tools available for fastener installation
      c. Proper storage for mechanical fasteners
d. Ensure steel roof deck is clamped to the supporting steel framing.
   2. Inspection Tasks During Mechanical Fastening
      a. Fasteners are positioned as required
      b. Examination of washer condition
c. Fastener’s are installed in accordance with MPII
   3. Inspection Tasks After Mechanical Fastening
      a. Check spacing, type, and installation of support fasteners
      b. Check spacing, type, and installation of sidelap fasteners
c. Check spacing, type, and installation of perimeter fasteners
d. Verify repair activities
e. Document acceptance or rejection of mechanical fasteners

E. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

F. Remove and replace work that does not comply with specified requirements.

G. Additional inspecting, at Contractor’s expense, will be performed to determine compliance of corrected work with specified requirements.
3.11 PROTECTION

A. Steel deck shall be protected against contact with materials that cause, or can be shown to cause, corrosion or other deterioration of the deck and accessories.

B. Pressure treated wood shall not be placed in direct contact with the steel deck without installing a protective barrier between the two.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

D. Deck areas subject to heavy or repeated traffic, concentrated loads, impact loads, wheel loads, or other like loading, shall be adequately protected by planking or other means to avoid overloading or damage.

E. Do not exceed construction load carrying capacity of steel roof deck sheets for type and span defined in SDI Construction Load Tables.

F. Do not use deck units as a working platform or storage area until units are permanently attached in position.

3.12 REPAIR / RESTORATION

A. Before placement of roof insulation and roof covering, the deck shall be inspected for tears, dents or other damage that may prevent the deck from acting as a structural roof base.
   1. The need for repair of the damaged deck shall be determined by the Structural Engineer of Record.

B. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

C. Welds: Repair all portions of the steel roof deck coating damaged due to weld heat with compatible paint type or zinc rich compound. Repair all burn through marks in accordance with SDI Deck Damage and Penetrations.

D. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
   1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

E. Mechanical Fasteners: Replace or supplement under-driven and over driven fasteners with adjacent, properly installed fasteners.

END OF SECTION 053123
SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Miscellaneous steel trim.
3. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Fasteners.
2. Shop primers.
3. Shrinkage-resisting grout.
4. Metal bollards.

B. Shop Drawings: Show fabrication and installation details.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.

D. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

E. Rolled-Stainless Steel Floor Plate: ASTM A793.
F. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

G. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

H. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.


K. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.


M. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).


2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum, stainless steel, or nickel silver.
2. Provide bronze fasteners for fastening bronze.

B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

C. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.
2.3 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099000 "Painting."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

B. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches (600 mm) o.c.

C. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.6 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.
2.7 LOOSE BEARING AND LEVELING PLATES
   A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
   B. Galvanize bearing and leveling plates.
   C. Prime plates with \textit{zinc-rich primer}.

2.8 LOOSE STEEL LINTELS
   A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
   B. Galvanize loose steel lintels located in exterior walls.
   C. Prime loose steel lintels located in exterior walls with \textit{zinc-rich primer}.

2.9 STEEL WELD PLATES AND ANGLES
   A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.10 GENERAL FINISH REQUIREMENTS
   A. Finish metal fabrications after assembly.

2.11 STEEL AND IRON FINISHES
   A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
      1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   B. Shop prime iron and steel items \textbf{not indicated to be galvanized} unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
      1. Shop prime with \textit{universal shop primer} unless \textit{zinc-rich primer} is indicated.
   C. Preparation for Shop Priming: Prepare surfaces to comply with \textit{SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."}, \textbf{requirements indicated below}:
      1. Exterior Items: \textit{SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."}
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. 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 surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   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 no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
B. Anchor supports for operable partitions, overhead doors, and overhead grilles securely to, and rigidly brace from, building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

3.3 INSTALLATION OF BEARING AND LEVELING PLATES


B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000
SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wood blocking and nailers.
   2. Plywood backing panels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-
test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.

2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat **all rough carpentry unless otherwise indicated.**

   1. Framing for raised platforms.
   2. Concealed blocking.
   3. Roof construction.
   4. Plywood backing panels.

2.3 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.
   5. Grounds.

B. Dimension Lumber Items: **Construction or No. 2** grade lumber of any species.

C. Concealed Boards: 19 percent maximum moisture content and the following species and grades:

   1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
   2. Eastern softwoods; No. 2 Common grade; NeLMA.
   3. Northern species; No. 2 Common grade; NLGA.
   4. Western woods; **Construction or No. 2 Common** grade; WCLIB or WWPA.
2.4  PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.5  FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC58 as appropriate for the substrate.

2.6  METAL FRAMING ANCHORS

A. Allowable design loads, as published by manufacturer, shall meet or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.


1. Use for interior locations unless otherwise indicated.

2.7  MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1  INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

C. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

D. Install shear wall panels to comply with manufacturer's written instructions.

E. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

F. Do not splice structural members between supports unless otherwise indicated.

G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

I. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

2. ICC-ES evaluation report for fastener.

END OF SECTION 061000
SECTION 064116 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-faced architectural cabinets.
2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-faced architectural cabinets that are not concealed within other construction.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
   a. Flame Spread Index: 25 or less.
   b. Smoke Developed Index: 450 or less

2. Manufacturer’s technical literature for decorative plastic laminate material, adhesive for bonding plastic laminate, miscellaneous accessories and related components.

B. Shop Drawings: For plastic-laminate-faced architectural cabinets.

1. Include plans, elevations, sections, and attachment details.

C. Samples: For each exposed product and for each color and texture specified.

1. Decorative plastic laminates, 5 by 7 inches, for each type, color, pattern, and surface finish.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements.

B. Grade: Custom.

C. Type of Construction: Frameless.
D. Door and Drawer-Front Style: Flush overlay.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as required by quality standard.

F. Laminate Cladding for Exposed Surfaces:
   1. Horizontal Surfaces: Grade HGS.
   2. Postformed Surfaces: Grade HGP.
   3. Vertical Surfaces: Grade HGS
   4. Edges: Grade HGS
   5. Pattern Direction: Vertically for doors and fixed panels, horizontally for drawer fronts.

G. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
   1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As selected by Architect from laminate manufacturer's full range in the following categories:
      a. Solid colors, matte finish.
      b. Solid colors with core same color as surface, matte finish.
      c. Wood grains, matte finish.
      d. Patterns, matte finish.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
   1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Section 087100. Where manufacturer’s name or product number is not indicated provide best quality commercially available cabinet hardware.
B. Butt Hinges: 2-3/4-inch (70-mm), five-knuckle steel hinges made from 0.095-inch- (2.4-mm-) thick metal, and as follows:
   1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.

C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening, self-closing.
   1. Provide three hinges for doors over 48 inches in height

D. Back-Mounted Pulls: BHMA A156.9, B02011.

E. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter]

F. Catches: Magnetic catches, BHMA A156.9, B03141

G. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081

H. Shelf Rests: BHMA A156.9, B04013; metal.

I. Drawer Slides: BHMA A156.9.
   1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.
      a. Type: Full extension.
      b. Material: Zinc-plated steel with polymer rollers.
   2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-overtravel-extension type; zinc-plated-steel ball-bearing slides.
   3. For drawers not more than 3 inches (75 mm) high and not more than 24 inches (600 mm) wide, provide Grade 1.
   4. For drawers more than 3 inches (75 mm) high, but not more than 6 inches (150 mm) high and not more than 24 inches (600 mm) wide, provide Grade 1HD-100.
   5. For drawers more than 6 inches (150 mm) high or more than 24 inches (600 mm) wide, provide Grade 1HD-200.
   6. For computer keyboard shelves, provide Grade 1HD-100.
   7. For trash bins not more than 20 inches (500 mm) high and 16 inches (400 mm) wide, provide Grade 1HD-200.

J. Slides for Sliding Glass Doors: BHMA A156.9, B07063; plastic.

K. Door Locks: BHMA A156.11, E07121.

L. Drawer Locks: BHMA A156.11, E07041.

M. Door and Drawer Silencers: BHMA A156.16, L03011.

N. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 2 or 3 (tinted), Quality-Q3, 6 mm thick unless otherwise indicated.
   1. Tint Color: As selected by Architect from Manufacturer’s Full range of tints.
2. Unframed Glass Doors: Seam exposed edges seamed before tempering.

O. Tempered Float Glass for Cabinet Shelves: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear) Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.

P. Grommets for Cable Passage: 2-inch (51-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Color: Black

Q. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
   1. Satin Stainless Steel: BHMA 630.

R. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.5 FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

C. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in GANA's "Glazing Manual."
   1. For glass in frames, secure glass with removable stops.
   2. For exposed glass edges, polish and grind smooth.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

B. Grade: Install cabinets to comply with quality standard grade of item to be installed.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of $\frac{1}{8}$ inch in 96 inches (3 mm in 2400 mm) using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

END OF SECTION 064116
PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Polyurethane waterproofing.

1.2 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings:
      1. Show locations and extent of waterproofing.
      2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.4 INFORMATIONAL SUBMITTALS
   A. Sample warranty.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.6 WARRANTY
   A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.
      1. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing: ASTM C 836/C 836M.

2.2 AUXILIARY MATERIALS

A. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated.

B. Sheet Flashing: 50-mil- (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.
   1. Adhesive: Manufacturer's recommended contact adhesive.

C. Membrane-Reinforcing Fabric: Manufacturer's recommended fiberglass mesh or polyester fabric.

D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; and as recommended by manufacturer for substrate and joint conditions.
   1. Backer Rod: Closed-cell polyethylene foam.

2.3 PROTECTION COURSE

A. Protection Course: ASTM D 6506, semirigid sheets of fiberglass- or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
   1. Thickness: 1/8 inch (3 mm), nominal.
   2. Adhesive: Rubber-based solvent type recommended in writing by waterproofing manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

F. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions and to recommendations in ASTM C 898/C 898M and ASTM C 1471/C 1471M.

G. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

H. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions and to recommendations in ASTM C 898/C 898M and ASTM C 1471/C 1471M. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

I. Install sheet flashing and bond to deck and wall substrates where required according to waterproofing manufacturer's written instructions.

3.2 WATERPROOFING APPLICATION

A. Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C 898/C 898M and ASTM C 1471/C 1471M.

B. Unreinforced Waterproofing Applications.

1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 60 mils (1.5 mm).

C. Install protection course with butted joints over waterproofing before starting subsequent construction operations.

1. For horizontal applications, install protection course loose laid over fully cured membrane.
2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.
3. Thermal insulation specified in Section 072100 "Thermal Insulation" may be used in place of a separate protection course for vertical applications when approved in writing by waterproofing manufacturer.

3.3 PROTECTION

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.
C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 071416
SECTION 071900 - WATER REPELLENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:

2. Precast concrete.
3. Concrete unit masonry.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each type of water repellent and substrate indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 PENETRATING WATER REPELLENTS

A. Siloxane, Penetrating Water Repellent: Clear, containing 10 percent or more solids of oligomerous alkylalkoxysiloxanes; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.

1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in representative locations by method recommended by manufacturer.
2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
3. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

3.2 PREPARATION

A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.

B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.

C. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

D. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using low-pressure spray to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.
1. **Precast Concrete and Cast Stone**: At Contractor's option, first application of water repellent may be completed before installing units. Mask mortar and sealant bond surfaces to prevent water repellent from migrating onto joint surfaces. Remove masking after repellent has cured.

   C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.4 **CLEANING**

   A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application.

   B. Comply with manufacturer's written cleaning instructions.

END OF SECTION 071900
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Polyisocyanurate foam-plastic board.
   2. Glass-fiber blanket.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Research reports.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type [IV, 1.60 lb/cu. ft. (26 kg/cu. m)] [X, 1.30 lb/cu. ft. (21 kg/cu. m)] [VI, 1.80 lb/cu. ft. (29 kg/cu. m)] [VII, 2.20 lb/cu. ft. (35 kg/cu. m)] [V, 3.00 lb/cu. ft. (48 kg/cu. m)], with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:

B. Molded-Polystyrene Board Insulation: ASTM C 578, Type [I, 0.90 lb/cu. ft. (15 kg/cu. m)] [VIII, 1.15 lb/cu. ft. (18 kg/cu. m)] [II, 1.35 lb/cu. ft. (22 kg/cu. m)], with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.

2.2 GLASS-FIBER BLANKET INSULATION

A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

B. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less);
Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene polypropylene-scrim-kraft vapor-retarder membrane on 1 face.

C. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:

1. 3-1/2 inches (89 mm) thick with a thermal resistance of [11 deg F x h x sq. ft./Btu at 75 deg F (1.9 K x sq. m/W at 24 deg C)] [13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C)].

2. 3-5/8 inches (92 mm) thick with a thermal resistance of 11 deg F x h x sq. ft./Btu at 75 deg F (1.9 K x sq. m/W at 24 deg C).

3. 5-1/2 inches (140 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).

4. 6-1/2 inches (165 mm) thick with a thermal resistance of 21 deg F x h x sq. ft./Btu at 75 deg F (3.7 K x sq. m/W at 24 deg C).

5. [9-1/2 inches (241 mm)] [10 inches (254 mm)] [10-1/4 inches (260 mm)] thick with a thermal resistance of 30 deg F x h x sq. ft./Btu at 75 deg F (5.2 K x sq. m/W at 24 deg C).

2.3 SLAG-WOOL-FIBER/ROCK-WOOL-FIBER BLANKET INSULATION

A. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

B. Faced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame spread of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene vapor-retarder membrane on 1 face.

C. Where slag-wool-fiber/rock-wool-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt form with thermal resistances indicated:

1. 1-1/2 inches (38 mm) thick with a thermal resistance of 6 deg F x h x sq. ft./Btu at 75 deg F (1 K x sq. m/W at 24 deg C).

2. 3-1/2 inches (89 mm) thick with a thermal resistance of 13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C).

3. 4 inches (101 mm) thick with a thermal resistance of 16 deg F x h x sq. ft./Btu at 75 deg F (2.8 K x sq. m/W at 24 deg C).

4. 5-1/4 inches (133 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).
5. 6 inches (152 mm) thick with a thermal resistance of 22 deg F x h x sq. ft./Btu at 75 deg F (3.9 K x sq. m/W at 24 deg C).

2.4 VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

B. Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 25 lb/1000 sq. ft. (12 kg/100 sq. m), with maximum permeance rating of 0.0507 perm (2.9 ng/Pa x s x sq. m).

C. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than 22 lb/1000 sq. ft. (10 kg/100 sq. m), with maximum permeance rating of 0.1317 perm (7.56 ng/Pa x s x sq. m) and with flame-spread and smoke-developed indexes of not more than 5 and 60, respectively.

D. Foil-Polyester-Film Vapor Retarders: 2 layers of 0.5-mil- (0.013-mm-) thick polyester film laminated to an inner layer of 1-mil- (0.025-mm-) thick aluminum foil, with maximum water-vapor transmission rate in flat condition of 0.0 g/h x sq. m and with maximum flame-spread and smoke-developed indexes of 5.

E. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

F. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

G. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.

H. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

2.5 AUXILIARY INSULATING MATERIALS

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by insulation manufacturers for sealing joints and penetrations in vapor-retarder facings.

B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

C. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.
2.6 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate formed from perforated galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square, welded to projecting copper-coated steel spindle 0.105 inch (2.67 mm) in diameter and of length capable of holding insulation of thickness indicated securely in position with 1-1/2-inch- (38-mm-) square or diameter self-locking washers complying with the following requirements:

1. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel sheet, with beveled edge for increased stiffness.
2. Where anchors are located in [ceiling plenums] protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.

B. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of [1 inch (25 mm)] [2 inches (50 mm)] [3 inches (76 mm)] between face of insulation and substrate to which anchor is attached.

C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of **24 inches (610 mm)** below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
1. If not otherwise indicated, extend insulation a minimum of **24 inches (610 mm)** in from exterior walls.

### 3.3 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

### 3.4 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately **24 inches (610 mm)** o.c. both ways on inside face and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

### 3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. Maintain **3-inch (76-mm)** clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.


5. For metal-framed wall cavities where cavity heights exceed **96 inches (2438 mm)**, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

6. For wood-framed construction, install blankets according to ASTM C 1320 and as follows:

   a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
7. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
   a. Exterior Walls: Set units with facing placed toward **interior of construction**.
   b. Interior Walls: Set units with facing placed **toward areas of high humidity**.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately **2.5 lb/cu. ft. (40 kg/cu. m)**.
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.6 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
2. Install insulation to fit snugly without bowing.

END OF SECTION 072100
SECTION 072500 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flexible flashing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 FLEXIBLE FLASHING

A. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

B. Rubberized-Asphalt Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturer's written instructions.
   1. Lap seams and junctures with other materials at least 4 inches (100 mm) except that at flashing flanges of other construction, laps need not exceed flange width.
   2. Lap flashing over water-resistive barrier at bottom and sides of openings.
   3. Lap water-resistant barrier over flashing at heads of openings.

END OF SECTION 072500
SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Adhered ethylene-propylene-diene-monomer (EPDM) roofing system.
   2. Roof insulation.

1.2 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.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Roofing Conference: Conduct conference at [Project site] <Insert location>.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
C. Samples for Verification: For the following products:
   1. Sheet roofing, of color required.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: For roofing system to include in maintenance manuals.

1.6 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

2.1 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.

2.2 PERFORMANCE REQUIREMENTS

A. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.

B. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

C. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, [Class A] [Class B] [Class C]; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

D. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.3 EPDM ROOFING

A. EPDM: ASTM D 4637, Type II, scrim or fabric internally reinforced, uniform, flexible EPDM sheet.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Carlisle SynTec Incorporated.
   b. Firestone Building Products.
   c. GAF Materials Corporation.
   d. Johns Manville; a Berkshire Hathaway company.

2. Thickness: 90 mils (2.2 mm), nominal.

2.4 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.
B. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.

C. Protection Sheet: Epichlorohydrin or neoprene nonreinforced flexible sheet, 55- to 60-mil- (1.4- to 1.5-mm-) thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.

D. Bonding Adhesive: Manufacturer's standard.

E. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

G. Miscellaneous Accessories: Provide lap sealant, water cutoff mastic, metal termination bars, metal battens, pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.5 ROOF INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density, square edged.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. Kingspan Insulation.
   d. Owens Corning.

B. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation[and cover boards] to substrate, and acceptable to roofing system manufacturer.

B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer.
C. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, **1/4 inch (6 mm)** thick.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   
a. **CertainTeed Corporation.**
b. **Georgia-Pacific Building Products.**
c. **National Gypsum Company.**

### 2.7 ASPHALT MATERIALS

A. Roofing Asphalt: **ASTM D 312, Type III or Type IV.**

B. Asphalt Primer: ASTM D 41/D 41M.

### PART 3 - EXECUTION

#### 3.1 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.

C. Install roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.

#### 3.2 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Install tapered insulation under area of roofing to conform to slopes indicated.

C. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is **2.7 inches (68 mm)** or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of **6 inches (150 mm)** in each direction.

   1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

D. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m), and allow primer to dry.

2. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

3. Set each layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

E. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck.

1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.3 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. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeters.

E. 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.

F. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, 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.

G. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

H. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal membrane roofing in place with clamping ring.
3.4 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.

3.5 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.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075323
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
5. Formed wall sheet metal fabrications.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Distinguish between shop- and field-assembled work.
3. Include identification of finish for each item.
4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.

C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
1. For copings and roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.6 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. Materials:

1. Sheet Metal Flashing and Trim, provide one of the following:
   a. Mill-Finished Aluminum Sheet: ASTM B 209, allow 3003-H14, and minimum thickness 0.040 inch thick.
   b. Extruded Aluminum: ASTM B 221, 6063-T52, 0.080 inches for primary legs of extrusion.
c. Anodized Aluminum Sheet: ASTM B 209, 5005-H14, with a minimum thickness of 0.050 inch thick.

B. Exposed Coil-Coated Finishes:
   1. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
   2. Color: As selected by Architect from manufacturer's full range.

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Self-Adhering Sheet Underlayment: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).

C. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
      b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
      c. Non-penetrating support system for gutters.
   2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
   3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
   4. Fasteners for (Galvanized) Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
D. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 REGLETS, RECEIVER FLASHING & COUNTER FLASHING

A. General: Provide reglets of type, material, and profile indicated, compatible with flashing. Form to securely interlock with counterflashing.

B. Counterflashing Wind Resistant Clips: Provide clips to be installed before counterflashing to prevent wind uplift of the counterflashing’s lower edge.

C. Material: Fabricate reglets from the following metal in thickness indicated.
   1. Aluminum Sheet: 0.050 inch thick, minimum.

D. Provide counterflashing fabricated from the same metal as reglets and compatible with reglet system installed.

E. Provide receiver flashing & counterflashing fabricated from the following metal in thickness indicated:
   1. Aluminum Sheet: 0.050 inch thick.

2.6 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA’s "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
   1. Obtain field measurements for accurate fit before shop fabrication.
   2. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
   3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
C. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

G. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

2.7 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Built-In Internal Gutters at the Translucent Structural Roof Panel System (Skylight): Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Fabricate with interlocking expansion joints, and gutter accessories from same metal as gutters. The interlocking joints shall be fabricated so that the water will flow over the expansion joints in a shingle fashion. Fabricate gutters with a high point at the center of the gutter, to create a slope to the downspouts at each end of the gutter. There shall not be an expansion joint at the high point of the gutter.
   1. Accessories: Non-penetrating support system for gutters. Provide all accessories, trim and components required to incorporate the gutter system within the Translucent Structural Roof Panel System and the Metal Wall Panel System, as shown on the drawings.
   2. Provide 40 mil Self-Adhering Sheet Underlayment as the interior lining of the complete interior surface of the Built-In Internal Gutters.

B. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal support hangers, from same material as downspouts, and anchors.
   1. Style / size: 4” x 6” internally installed within the Translucent Structural Roof Panel System and the Metal Wall Panel System, as shown on the drawings.
   2. Provide one downspout at each end of each gutter at each side of the Translucent Structural Roof Panel.
   3. Provide fittings and accessories as required to tie-in the downspouts to the underground storm drainage system.

C. Gutter and downspout material and finish:
   1. Aluminum sheet in thickness as recommended in the Architectural Sheet Metal Manual, Table 1-5 “Recommended Minimum Gauges for Gutter with factory-applied coil-coated finish.”
2.8 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Fascia: Manufactured, two-piece, roof edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet and a continuous formed- or extruded-aluminum anchor bar with integral drip edge cleat to engage fascia cover.
   1. Fascia Cover:
      a. Formed or extruded aluminum with factory-applied coil-coated finish in thickness as recommended by NRCA in “Guide for Sheet Metal Fascia Edges”.

2.9 WALL SHEET METAL FABRICATIONS

A. Metal Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot-(3.6-m-) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high, end dams where flashing is discontinuous. Fabricate from the following materials:
   1. Aluminum: 03050 inch thick.

B. Wall Expansion-Joint Cover: Fabricate from the following materials:
   1. Aluminum: 0.040 inch (1.02 mm) thick.

PART 3 - EXECUTION

3.1 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm). Cover underlayment within 14 days.

B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement so that completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
5. Install sealant tape where indicated.
6. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: 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 SMACNA.
1. Coat back side of uncoated aluminum sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.

D. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints as shown and as required for watertight construction.

F. Rivets: Rivet joints in uncoated aluminum where indicated and where necessary for strength.

3.3 ROOF DRAINAGE SYSTEM INSTALLATION
A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
B. Built-In Internal Gutters at the Translucent Structural Roof Panel System (Skylight): Join sections with riveted joints and sealed with sealant. Provide for thermal expansion. Install gutters within the Translucent Structural Roof Panel System and the Metal Wall Panel System, as shown on the drawings, firmly anchored with non-penetrating gutter brackets spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
1. Install gutter with interlocking expansion joints at each joint within the gutter.
2. Secure gutters with concealed fasteners.
3. Coordinate the installation of the gutters with the installation of the Translucent Structural Roof Panel System and the Metal Wall Panel System.
4. Line all interior surfaces of the gutter with the Self-Adhering Sheet Underlayment specified in this Section.

C. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide hangers with fasteners designed to hold downspouts securely in place. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
   1. Secure downspouts with concealed fasteners.
   2. Make final connection to the underground storm piping system with adapter fittings; seal all joints to the underground piping system with compatible sealant.
   3. Coordinate the installation of the downspouts with the installation of the Translucent Structural Roof Panel System and the Metal Wall Panel System. Coordinate the cutting-out of a portion of the top and bottom flanges of the steel support beam with the Structural Engineer and the structural steel fabricator.

3.4 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with sealant.

D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.5 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section "Unit Masonry."

C. Reglets: Installation of reglets is specified in Division 04 Section "Unit Masonry."
3.6 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturers written installation instructions.

END OF SECTION 076200
SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1.  Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
      a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
         1) UL in its "Fire Resistance Directory."
         2) Intertek Group in its "Directory of Listed Building Products."
         3) FM Global in its "Building Materials Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, 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: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
   1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
   1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
   2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
   3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.
E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

F. 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 system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

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. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. 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.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.

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.

3.2 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm)
of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. 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.

### 3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413
SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Latex joint sealants.
3. Urethane joint sealants.
5. Joint sealant backings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.

1.4 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL
   A. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICON JOINT SEALANTS
   A. Mildew-Resistant Silicone Joint Sealant: ASTM C 920.
      1. Type: Single component (S).
      2. Grade: nonsag (NS).

2.3 URETHANE JOINT SEALANTS
   A. Urethane Joint Sealant: ASTM C 920.
      1. Type: multicomponent (M).
      2. Grade: nonsag (NS).

2.4 LATEX JOINT SEALANTS
   A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.5 ACOUSTICAL JOINT SEALANTS
   A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2.6 JOINT SEALANT BACKING
   A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.
2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

1. Remove laitance and form-release agents from concrete.
2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of kind 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.
C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

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.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
   1. Joint Locations:
      b. Control and expansion joints in stone flooring.
      c. Control and expansion joints in brick flooring.
      d. Control and expansion joints in tile flooring.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.
      c. Tile control and expansion joints.
d. Vertical joints on exposed surfaces of interior unit masonry or concrete walls and partitions.
e. Joints on underside of plant-precast structural concrete beams and planks.
f. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.


3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Sealant Location:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.


3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.


1. Joint Location:
   a. Acoustical joints where indicated.


3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.
2.2 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Standard-Duty Doors and Frames: SDI A250.8, Level 1; SDI A250.4, Level C.

1. Doors:
   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: **1-3/4 inches (44.5 mm)**.
   c. Face: **Uncoated** steel sheet, minimum thickness of **0.032 inch (0.8 mm)**.
   d. Edge Construction: **Model 1, Full Flush**.
   e. Core: **Manufacturer's standard**.
   f. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.

2. Frames:
   a. Materials: **Uncoated** steel sheet, minimum thickness of **0.042 inch (1.0 mm)**.
   b. **Sidelite and Transom** Frames: Fabricated from same thickness material as adjacent door frame.
   c. Construction: **Full profile welded**.

2.3 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A 879/A 879M, Commercial Steel (CS), **04Z (12G)** coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.
2.4 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.5 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.6 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Hollow-Metal Frames: Comply with SDI A250.11.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
   a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
   b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113
SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-core doors with **wood-veneer** faces.
2. **Factory finishing** flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:
1. Section 088000 "Glazing" for glass view panels in flush wood doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of door.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

C. Samples: For **factory-finished doors**.

PART 2 - PRODUCTS

2.1 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI's, "Architectural Woodwork Standards."

B. WDMA I.S.1-A Performance Grade:

1. Heavy Duty unless otherwise indicated.
2. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces and exits.
3. Standard Duty: Closets (not including janitor's closets) and private toilets.

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
2. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
3. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

E. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde.
2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
3. Provide doors with [glued-wood-stave] [or] [structural-composite-lumber] cores instead of particleboard cores for doors indicated to receive exit devices.

F. Structural-Composite-Lumber-Core Doors:

   a. Screw Withdrawal, Face: 700 lbf (3100 N).
   b. Screw Withdrawal, Edge: 400 lbf (1780 N).

G. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.2 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces.
2. Species: Red Oak.
3. Cut: Plain sliced (flat sliced).
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Core: Either glued wood stave or structural composite lumber.
8. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.

2.3 LIGHT FRAMES

A. Metal Frames: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   1. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

C. Openings: Factory cut and trim openings through doors.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.5 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors that are indicated to receive transparent finish.

C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: AWIs, AWMAC's, and WT's "Architectural Woodwork Standards" System 11, catalyzed polyurethane.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Open-grain finish.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware.

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

1. Install fire-rated doors according to NFPA 80.
2. Install smoke- and draft-control doors according to NFPA 105.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.

   a. Comply with NFPA 80 for fire-rated doors.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

END OF SECTION 081416
SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of access door and frame and for each finish specified.

C. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

A. Flush Access Doors with Concealed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with beads for concealed flange installation.

2. Locations: Wall and ceiling.

3. Door Size: 16” x 16”

4. Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gauge

   a. Finish: Stainless Steel

5. Frame Material: Same material and thickness as door.


2.2 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.


G. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness according to ANSI H35.2 (ANSI H35.2M).

H. Frame Anchors: Same type as door face.

I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.

E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder locks, furnish two keys per lock and key all locks alike.
2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

F. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. 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.

D. Steel and Metallic-Coated-Steel Finishes:
   1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

E. Aluminum Finishes:
   1. Mill finish.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Comply with manufacturer's written instructions for installing access doors and frames.
   B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING
   A. Adjust doors and hardware, after installation, for proper operation.
   B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Storefront framing.

1.2 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
   2. Include point-to-point wiring diagrams.
C. Samples: For each type of exposed finish required.
D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance data.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 STOREFRONT SYSTEMS

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. Tubelite Inc. – TU24000 Series (Exterior) - Basis of Design
2. EFCO Corporation. – Xtherm Series 403X (Exterior)
3. YKK AP America Inc. – YES 45 XT Series (Exterior)

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

2. Glazing System: Retained mechanically with gaskets on four sides.
3. Finish: Clear anodic finish.
4. Fabrication Method: Field-fabricated stick system.
5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
6. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
2.2 ENTRANCE DOOR SYSTEMS

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. EFCO Corporation.
2. Tubelite Inc.
3. YKK AP America Inc.

B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.

1. Door Construction: **1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch-(3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.**
2. Door Design: **Wide stile; 5-inch (127-mm) nominal width with 10" bottom rail.**
   a. Provide nonremovable glazing stops on outside of door.

2.3 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

2.4 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.5 MATERIALS

A. Sheet and Plate: ASTM B209 (ASTM B209M).

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).

C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.

D. Structural Profiles: ASTM B308/B308M.
E. Steel Reinforcement:
   1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
   2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
   4. Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.
   6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 088000 "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

END OF SECTION 084113
SECTION 085113 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes aluminum windows for exterior locations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each exposed product and for each color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample warranties.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

   a. Window: 10 years from date of Substantial Completion.
   b. Glazing Units: Five years from date of Substantial Completion.
   c. Aluminum Finish: 10 years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AAMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: AW
2. Minimum Performance Grade: 60

C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.30 Btu/sq. ft. x h x deg F (1.71 W/sq. m x K)

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.27

E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.

F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C) ambient; 180 deg F (100 deg C) material surfaces.

2.2 ALUMINUM WINDOWS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, based on 4 ¾” Heavy Commercial projected flush face window.

a. Wausau – 4250i (Basis of Design)
b. EFCO – 450X
c. Additional manufacturers meeting the performance specifications will be considered.

B. Operating Types: Project out / fixed.


1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials.
and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

D. Insulating-Glass Units: ASTM E 2190.
   1. Glass: ASTM C 1036, Type 1, Class 1, q3.
      a. Tint: Clear.
      b. Kind: Fully tempered where indicated on Drawings.
   2. Lites: Two.
   3. Filling: Fill space between glass lites with argon.
   4. Low-E Coating: Solarban 60 or Guardian SN68.

E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

F. Hardware, General: Provide manufacturer's standard corrosion-resistant hardware sized to accommodate sash weight and dimensions.
   1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.

G. Projected Window Hardware:
   1. Hinges: Non-friction type, not less than two per sash.
   2. Lock: Manufacturer's standard.
   3. Limit Devices: Limit clear opening to 4 inches (100 mm) for ventilation; with custodial key release.

2.3 ACCESSORIES

A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.

B. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place with thermally broken sill starter with extruded sill extender.

2.4 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
   1. Type and Location: Full, inside for project-out sashes.

B. Aluminum Frames: Complying with SMA 1004 or SMA 1201.
Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D 3656/D 3656M.

1. Mesh Color: Manufacturer's standard.

2.5 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.6 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

E. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

F. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

G. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION 085113
SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Commercial door hardware.
   2. Cylinders and construction cores and construction keys.

1.2 WORK INCLUDED

A. This material supplier shall furnish at the building site or as otherwise directed, all finish hardware required for the proper operation of all doors shown on the bid plans except those listed under "WORK NOT INCLUDED".

B. Any opening shown on the bid plans, but not specifically listed under "HARDWARE SETS" shall be equipped with hardware of types and quality for similar openings specified.

C. The installation of these materials will be done by the General Trades Contractor. Materials will be installed in a neat and workman like manner, by mechanics skilled in this type of work. This supplier shall deliver all items of hardware properly marked and identified as to location.

D. Locks, trim and all other items to be fitted shall be protected by the General Trades Contractor during the painting and finishing period and this protection removed upon completion.

E. Prior to fabrication, this supplier shall advise the Architect of any items that may be unsuited due to detail or size of work to which finish hardware is to be applied.

F. After completion of the installation, this supplier or his representative will check the installation and adjustment of all finish hardware. This supplier will advise of any improper installation and assist in its correction as required. This supplier will assist in making any final adjustments necessary for the proper operation of this equipment.

G. See Division 08 door sections for astragals.

H. Lock Cores:
   1. The Permanent Lock cores and keys are provided and installed by the Owner’s Lock Core Contractor.
1.3 WORK NOT INCLUDED

A. Permanent lock cores and keys / keying are not included in the scope of work for this Section. These items are being provided and installed by Owner.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Action Submittals:

1. Door Hardware Sets: Prepared by or under the supervision of an Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams.

   a. Format: Use same scheduling sequence and format as in the Contract Documents in the Door and Hardware Institute’s Sequence and Format for approval within 30 days. Hardware schedule to be complete with Title page, Door Index/Keying Schedule and Manufactures legend. After “Approval” provide six (6) copies, unless otherwise requested, of the corrected, revised and approved schedule for field use, distribution and files. Provide one (1) copy complete with Catalog Cuts, marked “Installers Copy” and deliver it to the job site.

   b. Content: Include the following information:

      1) Identification number, location, hand, fire rating and material of each door and frame.

      2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.

      3) Complete designations of every item required for each door or opening including name and manufacturer.

      4) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.


1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.

   3. Installer’s responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing
consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

C. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure after 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.

E. Pre-installation Conference: Conduct conference at the project site prior to hardware installation the general contractor will set up a preinstall job site meeting with the hardware supplier, hardware installer and any other trades people deemed necessary (i.e. electrical contractor, security contractor, etc.) for communication to assure trouble free installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver door hardware to the project site in original manufacturer’s packaging and secure the materials.

1.7 COORDINATION

A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.

1. Warranty Period: One (1) years from date of Substantial Completion, except as follows:

a. Locksets and Cylinders: Five (5) years from date of Substantial Completion.
b. Door Closers (Except Electronic): Ten (10) years from date of Substantial Completion.
c. Door Closers (Electronic): Two (2) years from date of Substantial Completion.
d. Exit Devices (Electronic): Ten (10) years from date of Substantial Completion.
e. Hinges: Life of building.
f. Automatic Door Operator: Two (2) years from date of Substantial Completion.
1.9 Exit Devices (Except Electronic): Ten (10) years from date of Substantial Completion

EXTRA MATERIALS

A. Furnish full-size units of door hardware described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hardware: None required.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products. Note that even though an acceptable substitute manufacturer may be listed, the product must provide all the functions and features of the specified product or it will not be approved.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.

2.2 HINGES, GENERAL

A. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

B. Hinge Base Metal: Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel, with stainless-steel pin.
2. Interior Hinges: Steel, with steel pin.
3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.

C. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed. Provide non-removable pins for all out-swinging exterior doors and all out-swinging corridor doors with locks.

D. Fasteners: Comply with the following:

2. Wood Screws: For wood doors and frames.
3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
4. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors
   wood screws for wood doors. Finish screw heads to match surface of hinges.

2.3 HINGES

A. Butts and Hinges: BHMA A156.1.
B. Template Hinge Dimensions: BHMA A156.7.
C. Hinges specified manufacturer: Ives (IVE).
D. Approved acceptable substitute manufacturer:
   1. Bommer Industries, Inc. (BOM). BB5000 series
   2. Hager Companies (HAG). BB1279/BB1168 series
   4. Stanley Commercial Hardware (STA). FBB179/FBB168 series

2.4 CONTINUOUS HINGES

A. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves; joined
   by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust
   bearings. Provide full mortise hinges at hollow metal and aluminum doors. Provide full
   mortise with door edge protector at wood doors.
B. Continuous hinges specified manufacturer: Ives (IVE): 112HD and 224HD.
C. Approved acceptable substitute manufacturer:

2.5 LOCKS AND LATCHES, GENERAL

A. Accessibility Requirements: Provide operating devices that do not require tight grasping,
   pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not
   require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key,
   tool, or special knowledge for operation.
C. Electrified Locking Devices: BHMA A156.25.
D. Lock Trim:
   1. Levers: Schlage 17A lever and rose design.
E. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors.

F. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

G. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set.

2.6 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:

B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13, Grade 1; Series 1000.

C. Mortise locks must accept Schlage full size removable core (IC) mortise cylinders.

   1. Privacy Lockset: L9496

E. Approved acceptable substitute manufacturer:
   2. Sargent Manufacturing Company (SAR). 8200 x LNP series
   3. Dorma

2.7 AUXILIARY LOCKS AND LATCHES

A. Auxiliary Locks: BHMA A156.5, Grade 1.

B. All auxiliary locks that are to be included in the school’s master key system shall accept Schlage full-size removable core (IC) cylinders, without modification.

C. Auxiliary mortise locks specified manufacturer: Schlage (SCH).

D. Approved acceptable substitute manufacturer:
   2. Sargent Manufacturing Company (SAR). 4800 series
   3. Dorma

E. Electrical Strikes: Von Duprin 6300 surface mounted electrical strikes.
DOOR HARDWARE

DOOR BOLTS

E. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors.

1. Flush Bolt Heads: Minimum of 1/2-inch- (13-mm-) diameter rods of brass, bronze, or stainless steel with minimum 12-inch- (305-mm-) long rod for doors up to 84 inches (2134 mm) in height. Provide longer rods as necessary for doors exceeding 84 inches (2134 mm).

F. Manual Flush Bolts: BHMA A156.16, Grade 1; designed for mortising into door edge.


2. Approved acceptable substitute manufacturer:
   a. Burns Manufacturing Incorporated (BUR).
   b. Door Controls International (DCI).
   c. Hager Companies (HAG).
   d. Trimco (TRI).

G. Automatic Self-Latching Flush Bolts: BHMA A115.4, Grade 1; designed for mortising into door edge.


2. Approved acceptable substitute manufacturer:
   a. Burns Manufacturing Incorporated (BUR).
   b. Door Controls International (DCI).
   c. Hager Companies (HAG).
   d. Trimco (TRI).

H. Constant Latching Flush Bolts: BHMA A115.4, Grade 1; designed for mortising into door edge.

1. Constant Latching Flush Bolts specified manufacturer: Ives (IVE). FB50 Series for metal doors, FB60 Series for wood doors. Provide extended rod lengths for doors taller than 7'-0”

2. Approved acceptable substitute manufacturer:
   a. Burns Manufacturing Incorporated (BUR).
   b. Door Controls International (DCI).
   c. Hager Companies (HAG).
   d. Trimco (TRI).

I. Dutch Door Surface Bolts: BHMA A156.16; designed for surface installation on door face.

1. Dutch Door Surface Bolts specified manufacturer: Ives (IVE). SB0454

2. Approved acceptable substitute manufacturer:
a. Burns Manufacturing Incorporated (BUR).
b. Door Controls International (DCI).
c. Hager Companies (HAG).
d. Trimco (TRI).

J. Dustproof Strikes: ANSI/BHMA A156.16, Grade 1, L14011, US26D.

1. Dustproof strikes specified manufacturer: Ives (IVE), DP1 for thresholds or DP2 for floors.
2. Approved acceptable substitute manufacturer:
   a. Burns Manufacturing Incorporated (BUR).
   b. Door Controls International (DCI).
   c. Hager Companies (HAG).
   d. Trimco (TRI).

2.8 EXIT DEVICES

A. Exit Devices: BHMA A156.3, Grade 1.
   1. Vertical Rod or Rim type exit devices, as scheduled.

B. Mortise or Rim type cylinders as required for the application.

C. Must accept Schlage full-size removable core (IC) cylinders.

D. Accessibility Requirements: Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

E. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

F. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

G. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

H. Dummy Push Bars: Provide dummy push bars at interior vestibule doors and where scheduled. Dummy push bars shall be of the same series as the exit devices scheduled for similar doors.

I. Removable Mullions: Removable Mullions: Von Duprin KR 4854-Blank Steel with 313 Dark Bronze factory finish paint, key removable option, electrical for 2 surface mounted electrical strikes.
J. Outside Trim: Lever with cylinder, Pull with cylinder; material and finish to match locksets, unless otherwise indicated.

1. Match design for locksets and latchsets, unless otherwise indicated.


L. Approved acceptable substitute manufacturers:

1. Dorma Architectural Hardware (DRM). 9000 series
2. Precision Hardware, Inc. (PRE). Apex series
3. Sargent Manufacturing Company (SAR). 80 series

2.9 LOCK CYLINDERS

A. General

1. Provided and installed by this contractor.
2. Rim or Mortise type, as required for the application.
3. All auxiliary locks must accept Schlage full size removable core (IC) mortise cylinders.
4. All cylinders shall be Schlage full-size removable core (IC) cylinders for all applications that are to be keyed into the building’s master key system. Cylinders shall accept Schlage full size figure-8 removable (IC) cores. DPS standard, no substitution.
5. For applications that do not accept full-size cylinders, including but not limited to cabinet locks, padlocks, keyed control devices, etc., provide Schlage cylinders that accept Schlage full size figure-8 removable (IC) cores. DPS standard, no substitution
6. Complete with proper cams, tail pieces, blocking collars in appropriate thickness, and other related components required for the proper operation of the hardware device, without modification.
7. The completed installation of the cylinders shall accept the installation of the construction cores by this contractor and the installation of the permanent cores by the Owner’s Lock Core Contractor, without modification.

B. Standard Lock Cylinders: BHMA A156.5, Grade 1.

C. High-Security Lock Cylinders: BHMA A156.30, Grade 1; M, mechanical.


D. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Six.
E. Permanent Cores: Provide and installed by the Owner’s Lock Core Contractor.

F. Construction Keying: Comply with the following:
   2. Construction Cores: Provide construction cores for all keyed devices that are replaceable by permanent cores.

G. Specified manufacturer: “NO” others will be approved.
   1. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).

2.10 KEYING

A. The Permanent Keying System and the Permanent Keys are not in the scope of work for this Section and are the responsibility of the Owner’s Lock Core Contractor.

B. Construction Cores
   1. Provided and installed by this contractor.
   2. Provide keyed construction cores and keys during the construction period.
   3. Provide one construction core for each lockset and all other devices that accept full size figure-8 removable (IC) cores.
   4. Schlage Construction Core Part No. 23-030 ICC. Schlage Construction Key Part No. 48-101 ICC.
   5. The construction cores will be removed by the Owner’s Lock Core Contractor during the installation of the permanent lock cores and will be turned over to this contractor, along with the construction keys.
   6. This contractor shall return the construction cores and keys to the supplier under terms of their issuance.

D. Keying Schedule:
   1. Permanent Keying Schedule: Prepared and issued to the Owner by the Owner’s Lock Core Contractor.
   2. Construction Keying Schedule: Prepared and issued to the Owner by this contractor.

2.11 OPERATING TRIM

A. Standard: BHMA A156.6.

B. Materials: Fabricate from stainless steel, unless otherwise indicated.

C. Trim specified manufacturer: Ives (IVE).

D. Approved acceptable substitute manufacturer:
1. Burns Manufacturing Incorporated (BUR).
2. Hager Companies (HAG).
4. Trimco (TRI).

2.12 CLOSERS

A. Accessibility Requirements: Comply with the following maximum opening-force requirements:

1. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
2. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.

B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

C. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

D. Surface Closers: BHMA A156.4, Grade 1. Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.

E. Door Closers specified manufacturer: Dor-O-Matic (DOR) SC70 series.

F. Approved acceptable substitute manufacturer:


G. Coordinators: ANSI/BHMA A156.3:

1. Bar type with filler bars. Provide mounting where required to allow stop mounted hardware to be properly installed without damaging the coordinator.

2.13 PROTECTIVE TRIM UNITS

A. Kick Plates

1. Size: 2 inches less than door width on push side and 1 inch less than door width on pull side, by 8” high.

B. Mop Plates:

1. Size: 2 inches less than door width on push side and 1 inch less than door width on pull side, by 4” high.
C. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides, countersink screws; fabricated from the following material: Material: 0.050-inch- (1.3-mm-) thick stainless steel.

D. Protective Trim specified manufacturer: Ives (IVE).

E. Approved acceptable substitute manufacturer:
   a. Burns Manufacturing Incorporated (BUR).
   b. Hager Companies (HAG).
   c. Hiawatha, Inc. (HIA).
   d. Rockwood Manufacturing Company (ROC).
   e. Trimco (TRI).

2.14 STOPS AND HOLDERS

A. Stops and Bumpers: BHMA A156.16, Grade 1.
   1. Provide wall stops for all doors at locations where wall is adjacent to the door in its 110 degree open position; unless other type stops are scheduled or indicated.

B. Automatic Door Holders: ANSI/BHMA A156.16, L11291. Brass with US26D finish. Two piece unit with a heavy rubber pad to cushion the shock and to absorb the sound. The strike shall be adjustable 45 degrees left or right.
   1. Automatic door holders specified manufacturer: IVES (IVE) WS45 / WS45X.
   2. Approved acceptable manufacturer:
      a. Rockwood Manufacturing Company (ROC)
      b. Trimco (TRI)
      c. Architectural Builders Hardware Mfg. Inc (ASH)

C. Electromagnetic Door Holders: BHMA A156.15.

D. Silencers for Door Frames: BHMA A156.16, Grade 1; neoprene or rubber; fabricated for drilled-in application to frame.

E. Stops specified manufacturer: Ives (IVE).

F. Overhead stop/holders specified manufacturer: Glynn-Johnson (GLY) 100 Series Heavy Duty Concealed Stops/Holders.
   1. Refer to the Hardware Sets for the overhead stops that are to have the hold-open feature. The overhead stops with the hold-open feature shall be Model 100H Series hold-Open, with both selective and adjustable hold-open.
   2. All overhead stops and overhead stops/holders shall be concealed type.

G. Approved acceptable substitute manufacturer:
   1. Architectural Builders Hardware Mfg., Inc. (ABH).
   2. Burns Manufacturing Incorporated (BUR).
   3. Door Controls International (DCI).
   4. Hager Companies (HAG).
   5. Rixson Specialty Door Controls (RIX).
7. Trimco (TBM).

2.15 DOOR GASKETING

A. Standard: BHMA A156.22.

B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.

1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408. National Guard Products (NGP).

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.


G. Door gasket specified manufacturer: National Guard Products (NGP).

1. Approved acceptable substitute manufacturer.
   a. Hager Companies (HAG)
   b. Reese Enterprises (REE)
   c. Zero International (ZER)

H. Automatic Door Bottom: specified manufacturer: National Guard Products (NGP), Model 220NA.

1. Approved acceptable substitute manufacturer.
   d. Hager Companies (HAG)
   e. Reese Enterprises (REE)
   f. Zero International (ZER)

2.16 THRESHOLDS

A. Standard: BHMA A156.21.
B. Accessibility Requirements: Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.

C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch (13 mm) high.

D. Thresholds specified manufacturer: National Guard Products (NGP).

E. Approved acceptable substitute manufacturer:
   1. Hager Companies (HAG).
   2. Reese Enterprises (REE).

2.17 MISCELLANEOUS DOOR HARDWARE

A. Boxed Power Supplies: Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labeled for use with fire alarm systems.

B. Interface Box: Von Duprin JB7.


D. Power Transfer: Von Duprin EPT-2 or EPT-10, as required.

E. One-Way Viewer:
   1. Wide angle, 190° angle of view.
   2. Lens projects ¼" from face of door.
   3. 4 optical glass lenses.
   4. Solid brass body and barrel
   5. Conforms to ANSI/BHMA A156.2, L23172 and L23222.
   6. Finish: US 26D
   7. One Way viewer specified manufacturer: IVES.
   8. Approved acceptable substitute manufacturers:
      a. Stanley Commercial Hardware (STA).
      b. Hager Companies (HAG).
      c. Trimco (TRI).

2.18 FABRICATION

A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

B. Fasteners: Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-
head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Comply with NFPA 80 for fasteners of door hardware in fire-rated applications.

C. Finishes: BHMA A156.18, as indicated in door hardware sets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Steel Doors and Frames: Comply with DHI A115 Series. Drill and tap doors and frames for surface-applied door hardware according to ANSI A250.6.

B. Wood Doors: Comply with DHI A115-W Series.

C. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.

2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."

D. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

E. Key Control System: Tag construction keys and place them on hooks in the key control system cabinet, as determined by the construction keying schedule.

F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.

1. Configuration: Provide one power supply for each door opening.

G. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

H. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least...
3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

I. Automatic Door Holders: Mount roller unit near the top of the strikes side of the door. Mount the strike on the wall. Adjust the adjustable portion of the strike to engage into the roller unit.

J. Silencers: Lubricate silencers and install in frames prior to the grouting of the frames. Provide additional measures, if required, to insure that the silencers can be removed and reinstalled fully after the grouting of the frames. Remove the silencers after the frames have been grouted and install the silencers after the final painting of the door frames is complete.

3.2 FIELD QUALITY CONTROL

A. After all hardware has been installed, provide the services of a qualified hardware consultant to check for proper installation of hardware, according to the “Approved” hardware and keying schedule’s. Also, check the operation and adjustment of all hardware items in accordance with the manufacturer’s recommendations.

3.3 DOOR HARDWARE SCHEDULE

A. Provide hardware for each door to comply with requirements of this section “Door Hardware” hardware set numbers indicated in the door schedule, and in the following schedule of hardware sets.

B. It is intended that the following schedule includes all items of the finish hardware necessary to complete the work. If a discrepancy is found in the schedule, such as a missing item, improper hardware for a frame, door or fire codes, it shall be the responsibly of the hardware supplier to supply the proper materials.

C. All Permanent Lock Cores listed in the following individual Hardware Sets are deleted from this Section. All Permanent Lock Cores are provided and installed by the Owner’s Lock Core Contractor.

D. All Construction Cores (Temporary Cores) are provided and installed by this Section.

E. Hardware Sets:
HARDWARE SET #1 – CLASSROOM (20 MINUTE RATED DOOR)

1 SET HINGES
1 EA CLASSROOM LOCKSET
1 EA CYLINDER AND CORE
1 EA WALL STOP
1 EA MOUNTING PLATE
1 EA SURFACE CLOSER
1 EA KICKPLATE
3 EA SILENCERS

HARDWARE SET #2 – OFFICE (20 MINUTE RATED DOOR)

1 SET HINGES
1 EA OFFICE LOCKSET
1 EA CYLINDER AND CORE
1 EA WALL STOP
1 EA MOUNTING PLATE
1 EA SURFACE CLOSER
1 EA KICKPLATE
3 EA SILENCERS

HARDWARE SET #3 – RESTROOM (GROUP)

1 SET HINGES
1 EA CLASSROOM LOCKSET
1 EA CYLINDER AND CORE
1 EA MOUNTING PLATE
1 EA SURFACE CLOSER
1 EA KICKPLATE
3 EA SILENCERS

HARDWARE SET #4 – RESTROOM (SINGLE)

1 SET HINGES
1 EA PRIVACY LOCKSET
1 EA CYLINDER AND CORE
1 EA WALL STOP
1 EA MOUNTING PLATE
1 EA SURFACE CLOSER
1 EA KICKPLATE
3 EA SILENCERS

HARDWARE SET #5 – JANITOR

1 SET HINGES
1 EA STOREROOM LOCKSET
1 EA CYLINDER AND CORE
1 EA MOUNTING PLATE
1 EA SURFACE CLOSER
1 EA WALL STOP
1 EA KICKPLATE
3 EA SILENCERS
HARDWARE SET #6 – EXTERIOR – DOUBLE DOORS
2 SET HINGES
2 EA EXPOSED VERTICAL ROD PANIC DEVICES
2 EA RIM CYLINDER AND CORE
2 EA WALL STOPS
2 EA MOUNTING PLATES
2 EA SURFACE CLOSERS
1 SET WEATHERSEALS
1 EA THRESHOLD
2 EA SWEEPS
3 EA SILENCERS

HARDWARE SET #7 – EXISTING GYMNASIUM DOOR
REUSE EXISTING HARDWARE

END OF SECTION
SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Glass for **windows, doors, interior borrowed lites, storefront framing**.
2. Glazing sealants and accessories.

1.2 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Glass Samples: For each type of glass product other than clear monolithic vision glass; **12 inches (300 mm) square**.
C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: **10** years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions.
instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: **Five** years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

   1. Warranty Period: **10** years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2. PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the International Building Code and ASTM E 1300.

   1. Design Wind Pressures: As indicated on Drawings.
   2. Design Snow Loads: **As indicated on Drawings**.
   3. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
   4. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

C. Windborne-Debris-Impact Resistance: Exterior glazing shall comply with basic-protection testing requirements in ASTM E 1996 for **Wind Zone 1** when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on Project and shall be installed in same manner as glazing indicated for use on Project.

   1. Large-Missile Test: For glazing located within **30 feet (9.1 m)** of grade.
   2. Small-Missile Test: For glazing located more than **30 feet (9.1 m)** above grade.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. **U-Factors**: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. × h × deg F (W/sq. m × K).
2. **Solar Heat-Gain Coefficient and Visible Transmittance**: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
3. **Visible Reflectance**: Center-of-glazing values, according to NFRC 300.

### 2.2 GLASS PRODUCTS, GENERAL

**A. Thickness**: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

**B. Strength**: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

**C. Thermal and Optical Performance Properties**: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. **U-Factors**: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. × h × deg F (W/sq. m × K).
2. **Solar Heat-Gain Coefficient and Visible Transmittance**: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
3. **Visible Reflectance**: Center-of-glazing values, according to NFRC 300.

### 2.3 GLASS PRODUCTS

**A. Glass Types**:

1. **Float Glass**, ASTM C1036, Type I, Quality q.3
2. **Wire Glass**: Type II. Locations as noted on drawings
3. **Heat Treated Glass Products**: Tempered Glass ASTM C1048 to be used in the following:
   
   a. **Human Impact Hazard Condition**: Glazing conditions in which glass break age might readily occur through human activity. Such glazing locations shall be glazed with glass designation in this section for such use. The following location requires glazing with glass designation for human impact hazard condition; for multiple glazed lites, except as otherwise indicated, human impact hazard condition is limited to side of lite meeting the following conditions:

   1) Glazed lites in doors.

   2) Glazed lites with an exposed edge within 24 inches of a vertical edge of a door in closed position and the bottom exposed edge of the lite is less than 60 inches above the walking surface.
3) Glazed lites when all of the following apply:
   a. Exposed area of the lite is greater than 9 square feet.
   b. Exposed bottom of area lite is less than 18 inches above the floor.
   c. Exposed top edge of lite is greater than 36 inches above the floor.
   d. A walking surface is within 36 inches horizontally from the lite.
   e. Exposed lite is not protected on walking surface side(s) with a horizontal protective bar located 34 to 38 inches above floor which has vertical dimension of 1 1/2 inches and will not deflect into contact with light under a horizontal load of 50 pounds per square foot.

4) Exposed glazing installed as part of a railing/guard assembly.

5) Additional locations as required by the Ohio Building Code, Latest Edition.

6) Laminated Glass Units: Polyvinyl butyral inner layer.

7) Sealed Insulating Glass Units: ASTM E 774, Class A
   a. Provide low-emissivity insulating glass units.
   b. Coated interior face of panel.


B. Glass Usage:

1. Exterior:
   a. Glass for Exterior Doors:
      1) ¼ inch thick, tempered glass to match exterior windows units.
         a. Exterior Sidelights and Transoms: Outer light to be ¼” Solarban 60 or Guardian SN68 low “e” glass, inner light to be ¼” clear float glass. Provide tempered glass at locations as required per OBC and/or human hazard locations. Tint as selected by Architect from full range of standard colors and light transmissions.
      b. Glass for Exterior Storefront and other insulated applications:
         1) Insulated unit: Outer light to be ¼” Solarban 60 or Guardian SN68 low “e” glass, inner light to be ¼” tinted float glass to match existing building glazing. Provide tempered glass at locations as required per OBC and/or human hazard locations. Tint as selected by Architect from full range of standard colors and light transmissions.

2. Interior:
b. Glass for Interior Fire Rated Doors: ¼ inch clear wire glass, polished both sides.
c. Glass for Interior Fire Rated Windows: Fire rated glass, per required rating (see drawings), similar to Specifire by TGP.
d. Glass for Interior Non-Fire Rated Doors and Windows: ¼ inch clear tempered safety glass.

C. Glazing Sealants

1. General
   a. Provide materials as recommended by the manufacturer for the required application and condition of installation in each case. Provide only compounds which are proven to be fully compatible with surfaces contacted.

2. Silicone Rubber Glazing Sealant: Shall be silicone rubber, one part elastomeric sealant complying with FS TT-S-001543, Class A. Provide acid type for nonporous channel surfaces and provide nonacid medium-modulus type for porous channel surfaces.

3. Preformed Butyl Rubber Glazing Sealant: Shall be tape or ribbon (coiled on release paper) of polymerized butyl or mixture of butyl and polyisobutylene, compounded with inert fillers and pigments, solvent-based with minimum of 95 percent solids with thread or fabric reinforcement, tack-free within 24 hours, paintable, nonstaining.
   a. Provide combination tape and encased continuous rubber shim of approximately 50 durometer hardness.

4. Two Component Polysulfide Glazing Sealant: Shall be polysulfide 2 part elastomeric sealant, complying with FS TT-S-00227, Class A, Type 2 (nonsag) with container bearing Thiokol Chemical Corp. seal of approval. Material shall be compounded by manufacturer specifically for glazing.

D. Glazing Gaskets

1. Polyvinyl Chloride Glazing Gaskets: Shall be extruded, flexible PVC gaskets of the profile and hardness shown or as required for watertight construction, complying with ASTM D2287.

2. Structural Rubber Glazing Gaskets: Shall be neoprene extrusions with injection molded corner units, fabricated into frames with either integral or separate locking strips (zippers), complying with ASTM C542, black.

E. Miscellaneous Glazing Materials

1. Setting Blocks: Shall be neoprene, 70-90 durometer hardness with proven compatibility with sealants used.

2. Spacers: Shall be neoprene, 40-50 durometer hardness with proven compatibility with sealants used.
3. Compressible Filler Rod: Shall be closed-cell or waterproof jacketed rodstock of synthetic rubber or plastic foam with proven compatibility with sealants used. Rod shall be flexible and resilient with 5-10 PSI compression strength for 25 percent deflection.

4. Cleaners, Primers and Sealers: Shall be products as recommended by sealant or gasket manufacturer.

F. Each light of tempered, laminated, glass shall bear permanent identification by the manufacturer, indicating type, thickness and manufacturer's name.

G. Exterior and vestibule glass units shall withstand 15 PSF windload.

H. Provide for expansion control in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
3.2 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Apply heel bead of elastomeric sealant, where required by the glazing manufacturer, for the application.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.
3.4 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

A. Protect exterior 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.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Responsibility for glass breakage shall be assumed by this Contractor until glass is properly set by him, and he shall replace all broken glass caused by binding or faulty setting.

END OF SECTION 088000
SECTION 089119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fixed, extruded-aluminum louvers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

C. Samples: For each type of metal finish required.

D. Delegated-Design Submittal: For louvers indicated to comply with structural performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on tests performed according to AMCA 500-L.

B. Windborne-debris-impact-resistance test reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
1. Wind Loads: Determine loads based on a uniform pressure of **20 lbf/sq. ft. (957 Pa)** [**30 lbf/sq. ft. (1436 Pa)**], acting inward or outward.

C. Windborne-Debris-Impact Resistance: Louvers located within **30 feet (9.1 m)** of grade shall pass basic-protection, large-missile testing requirements in ASTM E 1996 for **Wind Zone 1** when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than louvers indicated for use on Project.

D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

2.2 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T52.

B. Fastenings: Use same material as items fastened, unless otherwise indicated. Fasteners for exterior applications may be hot-dip galvanized, stainless steel or aluminum. Provide types, gauges and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

C. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

D. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

E. Provide ½” mesh, 063” aluminum bird screen in removable extruded aluminum frames.

2. FABRICATION, GENERAL

A. Provide louvers and accessories of design, materials, sizes, depth, arrangement, and metal thicknesses as shown on drawings, or if not shown, as required for optimum performance with respect to air flow; water penetration; air leakage, where applicable (for adjustable units, if any); strength; durability; and uniform appearance, as suited to applications shown and intended use.

B. Fabricate frames including integral sills to suit adjacent construction with adequate tolerances for installation including application of sealants in joints between louvers and adjoining work, where applicable.

C. Include supports, anchorages, and accessories required to achieve a complete assembly, properly installed.

D. Provide concealed vertical mullions of type and at spacings indicated but not further apart than recommended by manufacturer, or 72”, whichever is less. At horizontal joints between louver units, provide horizontal mullions except where continuous vertical assemblies are indicated.
E. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field bolted connections between frame members are made necessary by size of louvers. Maintain equal blade spacing including separation between blades and frames at head and sill to produce a uniform appearance.

3. STATIONARY EXTRUDED ALUMINUM WALL LOUVERS

A. Horizontal Drainable Blade Louvers: Units designed to collect and drain water to exterior at sill by means of gutters in front edges of blades, and channels in jambs and mullions. Furnish units with extrusions not less than 0.081” thick, 6” depth, and sizes indicated, complying with the following performance requirements:

1. Provide free area, static pressure loss, and water penetration limitations as specified in Division 15.

2. Furnish blank-off panels as required to close off unused open areas of louver. Coordinate size with HVAC contractor.

4. METAL FINISHES

A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products are assembled. Protect finishes on exposed surfaces with protective covering, prior to shipment. Remove all scratches and blemishes from exposed surfaces which will be visible after completing finishing process.

B. Finish:

1. Two coat fluopolymer coating utilizing 70% Kynar 500 resin. Finish shall comply with performance criteria of AAMA 605.2, selected from manufacturers list of standard colors by Architect.

PART 3 - EXECUTION

1. PREPARATION

Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the project site.

2. INSTALLATION

A. Locate and place louver units plumb, level and in proper alignment with adjacent work.

B. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.
D. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, at Contractor's option.

E. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.

F. Refer to Division 7 sections for sealants in connection with installations of louvers.

END OF SECTION 089119
SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior partitions.
   2. Suspension systems for interior ceilings and soffits.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Steel Studs and Runners: ASTM C 645.
   1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
   2. Depth: As indicated on Drawings, 3-5/8 inches (92 mm) or 6 inches (152 mm).

B. Slip-Type Head Joints: Where indicated, provide the following in thickness not less than indicated for studs and in width to accommodate depth of studs:
   1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (51-mm-) deep flanges, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
   2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.
   3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.
C. Firestop Tracks: Manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).

E. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: 1-1/2 inches (38 mm).
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
   2. Depth: [As indicated on Drawings] [7/8 inch (22.2 mm)] [1-1/2 inches (38.1 mm)].

G. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
   1. Configuration: Asymmetrical or hat shaped.

H. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: 3/4 inch (19 mm).
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Capable of sustaining a load equal to 5 times that imposed as determined by ASTM E 488.
a. Type: Postinstalled, expansion anchor.

2. Powder-Actuated Fasteners: Capable of sustaining, a load equal to 10 times that imposed as determined by ASTM E 1190.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: 1-1/2 inches (38 mm).

F. Furring Channels (Furring Members):
   1. Cold-Rolled Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
   2. Steel Studs and Runners: ASTM C 645.
      a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
      b. Depth: [As indicated on Drawings] [3-5/8 inches (92 mm)].

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.
   a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).

4. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
   a. Configuration: Asymmetrical or hat shaped.

2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

6. Curved Partitions:
   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.

E. Direct Furring:
   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Z-Furring Members:
   1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
   2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
   3. 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. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.3 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

3. Do not attach hangers to steel roof deck.

4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.

6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior gypsum board.
   2. Exterior gypsum board for ceilings and soffits.
   3. Tile backing panels.
   4. Texture finishes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch (15.9 mm).
   2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
B. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
   1. Thickness: 1/4 inch (6.4 mm).
   2. Long Edges: Tapered.

C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
   1. Thickness: 1/2 inch (12.7 mm).
   2. Long Edges: Tapered.

D. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
   1. Core: 5/8 inch (15.9 mm), Type X.
   2. Long Edges: Tapered.

   1. Core: 5/8 inch (15.9 mm), Type X.
   2. Long Edges: Tapered.
   4. Provide at all exposed wall locations, 8’-0” A.F.F. unless noted otherwise.

2.4 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.
   1. Core: 5/8 inch (15.9 mm), Type X.

B. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.
   1. Core: 5/8 inch (15.9 mm), Type X.

2.5 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325. Formed in a continuous process of aggregated Portland cement slurry with polymer-coated glass-fiber mesh completely encompassing edges and front & back surfaces with manufacturer's standard formed smooth edges.
   1. Thickness:
      a. 5/8 inch (15.9 mm), for installation over metal studs, in lieu of 5/8” gypsum board at wall areas scheduled to receive tiling specified in Division 09 Section “Tiling”.
b. ½” (12.7 mm) for installation over new CMU walls, or all types of existing walls, scheduled to receive tiling specified in Division 09 Section “Tiling”.


2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

   1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.

C. Aluminum Trim: ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

D. Gypsum board aluminum reveals, square.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.8 AUXILIARY MATERIALS

A. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   1. Laminating 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. Laminating 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. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

C. Sound Attenuation Blankets: As specified in Division 07 Section “Thermal Insulation”.

GYPSUM BOARD
D. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.

1. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Acoustical joint 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. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

F. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

A. Comply with ASTM C 840.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. Install trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

1. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

E. Prefill open joints, rounded or beveled edges, and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile or panels that are substrate for acoustical tile.
3. Level 3: Not used
4. Level 4: All gypsum board surfaces that will be exposed to view unless otherwise indicated.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.
5. Level 5: At locations as noted on drawings.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.

H. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

I. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900
SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Porcelain tile.
   2. Glazed wall tile.
   3. Tile backing panels.
   4. Waterproof membrane [for thinset applications].
   5. Crack isolation membrane.
   6. Metal edge strips.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples:
   1. Each type and composition of tile and for each color and finish required.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 2 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.
PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

A. Ceramic Tile Type: Unglazed porcelain tile.
   1. Acceptable manufacturers
      a. Dal-Tile
      b. American Olean
      c. Florida Tile
   2. Certification: Tile certified by the Porcelain Tile Certification Agency.
   3. Face Size: 11-13/16 by 11-13/16 inches (300 by 300 mm)
   4. Face Size Variation: Rectified.
   5. Thickness: 3/8 inch (9.5 mm).
   6. Face: Plain with square edges.
   7. Dynamic Coefficient of Friction: Not less than 0.42.
   8. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
   9. Grout Color: As selected by Architect from manufacturer's full range.
   10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

      a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
      b. External Corners: Surface bullnose, module size same as adjoining flat tile.
      c. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.

2.3 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

   1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
2.4 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, Type A.
   1. Thickness: 1/2 inch (12.7 mm).

2.5 WATERPROOF MEMBRANE

A. General: Manufacturer's standard product[, selected from the following,] that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Waterproofing and Tile-Setting Adhesive: One-part, fluid-applied product intended for use as both waterproofing and tile-setting adhesive in a two-step process.

2.6 SETTING MATERIALS


B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.
   1. For wall applications, provide nonsagging mortar.

C. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.

D. Organic Adhesive: ANSI A136.1, Type I.

2.7 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.


C. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.

2.8 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; white zinc alloy exposed-edge material.

C. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

   a. Exterior tile floors.
   b. Tile floors in wet areas.
   c. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.
   d. Tile floors consisting of rib-backed tiles.
B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Quarry Tile: 1/4 inch (6.4 mm).
2. Porcelain Tile: 1/4 inch (6.4 mm).

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile and where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

K. Floor Sealer: Apply floor sealer to grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

L. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

M. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
N. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

END OF SECTION 093013
SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Acoustical tiles for interior ceilings.
   2. Fully concealed, direct-hung, suspension systems.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS
A. Product test reports.
B. Research reports.
C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: Class A according to ASTM E 1264.
   2. Smoke-Developed Index: 450 or less.
2.2 ACOUSTICAL TILES

A. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264.

B. Color: White

C. Light Reflectance (LR): Not less than 0.85

D. Ceiling Attenuation Class (CAC): 35

E. Noise Reduction Coefficient (NRC): Minimum .70.

F. Edge/Joint Detail: Square, kerfed, and rabbeted; tongue and grooved; or butt.

G. Thickness: 3/4 inch

H. Modular Size: As indicated on Drawings

I. Basis of Design: School Zone Fine Fissured, 1714 by Armstrong Ceilings & Wall Solutions

2.3 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C 635/C 635M.

B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation.

2. Access: Upward and end pivoted or side pivoted, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.

2.4 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

B. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.
PART 3 - EXECUTION

3.1 PREPARATION
   A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.
   B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS
   A. Install suspended acoustical tile ceilings according to ASTM C 636/C 636M, seismic design requirements, and manufacturer's written instructions.
   B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
      1. Do not use exposed fasteners, including pop rivets, on moldings and trim.
   C. Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

END OF SECTION 095123
SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermoset-rubber base.
   2. Rubber molding accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE RB-1

A. Manufacturers: Subject to compliance with the requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Roppe Corporation
   2. Johnsonite Inc.
   3. Flexco Inc.

B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

C. Thickness: 0.125 inch (3.2 mm).

D. Height: 4 inches (102 mm) unless noted otherwise

E. Lengths: Cut lengths 48 inches (1219 mm) long. Material in rolls is not acceptable.

F. Outside Corners: Preformed.

G. Inside Corners: Preformed.

H. Colors: As selected by Architect from Manufacturer’s Full range
2.2 RUBBER MOLDING ACCESSORY

A. Comply with manufacturer’s written instruction for installing resilient accessories

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet ad resilient floor covering that would otherwise be exposed.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

B. Do not install resilient products until materials are the same temperature as space where they are to be installed.

C. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
G. Preformed Corners: Install preformed corners before installing straight pieces.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513
SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vinyl Composite Tile

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each exposed product and for each color and pattern specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL COMPOSITION TILE

A. Manufacturers
   1. Basis of Design: Armstrong, Standard Excelon Imperial Texture
      a. Colors: Washed Linen (51810) and Earthstone Greige (51804).
      b. Size: 12 in. x 12 in. x 1/8 in.
2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than \[ \frac{9}{10} \] \( \text{pH} \).
4. Moisture Testing: Perform tests so that each test area does not exceed \( 1000 \text{ sq. ft.} \), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
   a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of \( 3 \text{ lb of water/1000 sq. ft.} \) \( (1.36 \text{ kg of water/92.9 sq. m}) \) in 24 hours.
   b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 95 percent relative humidity level measurement.

C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.

D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

E. Do not install floor tiles until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
3.2 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles in pattern indicated on drawings.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles in pattern of colors and sizes indicated.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

END OF SECTION 096519
SECTION 09 90 00 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. All provisions of the Contract Documents apply to this Section. The Contractor for this Section shall be responsible for complete familiarity with same.

1.2 SCOPE OF WORK
A. Preparation of surfaces for painting and finishing and for the painting and finishing of all exposed surfaces to receive one of the applications specified in this Section.
B. Puttying set nail heads and repairing other blemishes in wood, gyp board and plaster.
C. Priming and back priming of all wood surfaces.
D. Painting miscellaneous items in walls and ceilings, and any other items not otherwise specified.
E. Painting all visible surfaces of light fixtures, grille work, mechanical and electrical equipment not painted or pre-finished.
F. Painting of all exposed ductwork, piping, conduit, insulation, brackets and hangers in all areas unless noted otherwise.
G. Painting portion of ductwork interior or other surfaces visible through grilles, flat black.
H. Contractor to assume all walls, exposed structure, ductwork, conduits, piping and ceiling will be painted with different colors as selected by the Architect. Surfaces in a room or area to receive painted finishes may have different colors of paint used.

1.3 WORK NOT INCLUDED OR SPECIFIED IN OTHER SECTIONS
A. Shop priming specified in other Sections.
B. Copper, brass, aluminum, stainless steel and other non-ferrous metals shall not be painted unless specifically noted otherwise.
1.4 SYSTEM DESCRIPTION

A. Environmental Requirements

1. Painting manufacturer and Contractor shall conform to State and local V.O.C. (Volatile Organic Compound) Regulations in area where Project is located.
   a. VOC content shall be a maximum 340 gm/liter, for field applied finishes.

1.5 SUMMARY

A. This Section includes surface preparation and the application of paint systems specified in this section: Adjust list below to suit Project.

1.6 SUBMITTALS

A. Before materials are ordered, submit a complete list of proposed materials for each type of product listed. When requested, submit product data and a complete specifications and samples of materials for approval.

B. Samples:
   1. Color schedule will be furnished by the Architect prior to commencement of painting work, and from this the painting contractor shall prepare duplicate set of samples of treatments for all major surfaces.
   2. Samples shall each be made on material like that to be treated and the material shall be positioned, during execution of the sample, to simulate the job conditions, i.e., vertical, overhead horizontal, or below eye level horizontal.
   3. When approved, samples will be so marked, with one set retained by Architect and one by painting contractor. Approved sample shall be strictly duplicated in the work. Additional coats, if required to reproduce approved samples, shall be applied by the Contractor without additional cost to the Owner.

1.7 QUALITY ASSURANCE

A. Codes and Standards: Comply with pertinent codes and regulations.

1.8 EXTRA MATERIALS

Provide Owner, at completion of job, with one (1) gallon (3.8L) of paint in each color selected. Paint to be supplied in tightly sealed containers labeled with color numbers as listed in the final color schedule.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
   2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
   3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
   4. Floor Coatings: VOC not more than 100 g/L.
   5. Shellacs, Clear: VOC not more than 730 g/L.
   6. Shellacs, Pigmented: VOC not more than 550 g/L.

C. Colors: As indicated in a color schedule

D. MATERIALS

E. All paint, varnish, enamel, lacquer, and related materials shall be first quality standard products of established manufacturers who have continuous performance in the manufacture of each product for 10 years and approved by the Architect. Provide best quality, first line grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade, first line product will not be acceptable. All materials shall comply with the VOC Content requirements listed in this Section. The following manufactures are acceptable:

   1. Benjamin-Moore
   2. Sherwin-Williams
   3. Porter Paint Company

Other manufactures will be considered, providing performance regarding scrubability and hiding power are equal to or exceed manufactures listed above. Documentation of performance tests by an independent testing laboratory are required before approval.

F. Epoxy coatings shall be equal to those manufactured by Porter Paint Company. Materials by other manufacturer's require Architect's approval prior to submission of proposal. Epoxy coating colors shall not necessarily be selected from manufacturer's standard colors.

G. All materials shall be delivered to the site in unopened original containers, bearing the brand name and the manufacturer's name, and having seals intact. Containers shall not be opened until contents are ready to be used.

H. No materials shall be reduced or changed except as indicated by manufacturer's directions on containers.

I. Thinners and dryers shall be added only in accordance with the manufacturer's printed instructions. Paints with solids shall be mixed at least 24 hours before use and shall be re-mixed before application. Turpentine shall conform to ASTM Standard Specifications D-13.

J. In selecting painting materials, the Contractor shall take into consideration special atmospheric conditions prevailing and any excessive treatment to which the particular surfaces might be subject.
K. All latex paints specified shall be 100% latex base.

2.2 PAINTING SCHEDULE

A. Any surface visible in the completed project except floors and areas noted unpainted on the drawings; shall be painted in accordance with the following descriptions:

B. Exterior Surfaces:

1. Fabricator-primed Ferrous Metals
   a. Spot-prime abrade shop primed areas
   b. 2 coats exterior alkyd gloss enamel

2. Non-primed Ferrous Metals
   a. 1 coat lead-free alkyd primer
   b. 2 coats gloss alkyd enamel

3. Exterior Gypsum Board Sheathing
   a. 1 coat primer
   b. 2 coats semi-gloss exterior grade latex

4. Masonry (non-texture surfaces)
   a. 1 coat primer
   b. 2 coats exterior grade latex

5. Exterior Concrete / Masonry Coating System
   a. 1 coat primer
   b. 1 coat (min.) of high-build acrylic coating to achieve uniform appearance

B. Interior Surfaces:

1. Gypsum Board
   a. 1 coat primer
   b. 2 coats low luster latex enamel

   or for surfaces indicated on drawings to receive epoxy coating:

   a. 1 coat latex wall sealer
   b. 2 coats water based catalyzed epoxy paint

2. Wood / Plywood (Painted)
   a. 1 coat enamel primer
   b. 2 coats alkyd semi-gloss enamel, unless epoxy paint is called for, then water based epoxy paint shall be used
3. Hardwood (Stained)  
a. 1 coat alkyd wood stain (omit if natural is desired by Architect)  
b. 1 coat urethane filler-sealer  
c. 2 coats clear satin urethane  

4. Fire Retardant Treated Plywood  
a. 1 coat primer  
b. 2 coats low luster Latex enamel  

5. Masonry  
a. 1 coat block filler  
b. 2 coats alkyd eggshell enamel  

6. Masonry (Epoxy system)  
a. 1 coat block filler  
b. 2 coats water based catalyzed epoxy-coating  

7. Fabricator or manufacturer primed Ferrous Metals  
a. 2 coats interior alkyd semi-gloss enamel  

8. Non-primed Ferrous Metals  
a. 1 coat lead-free alkyd metal  
b. 1 coats alkyd semi-gloss enamel  

9. Overhead Structure, Piping, Conduits and Ductwork  
a. Waterborne Acrylic Dry Fall  
b. Flat Finish  
c. Tinted, color to match existing building color scheme  

PART 3 - EXECUTION  

3.1 EXAMINATION  

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.  

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:  
   1. Concrete: 12 percent.  
   3. Wood: 15 percent.  
   4. Plaster: 12 percent.  
   5. Gypsum Board: 12 percent.  

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
D. Before commencing work on surfaces of any type, the Painting Contractor shall carefully inspect same and satisfy himself that they are dry and in all other respects suitable to receive the specified treatment. If the condition of any surface is such that it cannot be put in proper condition by normal preparatory methods, and arrangements for prompt correction cannot be made at once with the General Contractor, the Painting Contractor shall not undertake surface preparation and shall, instead, at once address a written request to the General Contractor for corrections which will provide an acceptable surface.

E. Application of any coating to a surface will constitute acceptance of the surface by the Painting Contractor. If after treatment, the completed finish (or any portion thereof) blisters, checks, peel, or otherwise shows indication of dampness or other irregular condition of surface, the Painting Contractor shall, at his own expense, remove the applied treatment and refinish the part affected to the satisfaction of the Architect. (The Painting Contractor should determine dryness of all moisture-holding materials by use of a reliable electronic moisture meter).

F. Each coat of material applied must be inspected and approved by the Architect before the application of the succeeding specified coat; otherwise, no credit for the concealed coat will be given and the Painting Contractor shall assume the responsibility to recoat the work in question. The Painting Contractor shall notify the Architect, when each coat is completed, for inspection.

3.2 USE OF PREMISES

A. No plumbing fixture, open waste, drain, or vent pipe (or other pipe of any kind), shall be used to dispose of paint materials, used rags, waste, or other materials.

B. New materials of all kinds, shall not be used as supports for planking and shall be thoroughly protected from damage at all times.

C. Provide, erect and maintain all staging and scaffolding required for execution of the work, move when necessary at the option of the Architect, to permit installation of other work. Remove from premises promptly at completion of work.

3.3 PREPARATION AND APPLICATION

A. Comply with manufacturer's written instructions and recommendations for preparation and application.

B. Before painting is started in an area, finish carpentry, including correction and adjustments shall have been completed, all glazing installed and the area of the building cleaned of all debris, thoroughbly broom cleaned and dusted out. All plastering and drywall shall be finished and shall be thoroughly dry.

C. Finish hardware and plates for electric outlets shall have been fitted by the General and Electrical Contractors, and shall be removed by and replaced by the Painting Contractor.

D. Nail holes in all exposed woodwork shall be filled with putty colored to match accurately the approved finishes. Seal knots and pitch streaks before applying primer. Shellac on interior, spar varnish on exterior.

E. Sandpapering of all wood joints and exposed wood surfaces shall follow paint priming or wood stain application on natural finish work and shall precede second coat work. Sand only with the grain.

F. Metal surfaces shall be smooth and thoroughly cleaned of grease, rust, scale and dust. Shop coats that are marred or abraded shall be cleaned and touched up with primer matching the shop coat.
G. When part will be exposed to view, sandpaper the entire treated area smooth, feather the edge of surrounding undamaged prime coat, and extend spot priming onto same, in a manner to eliminate evidence of repair.

H. Before painting any metal, the surfaces shall be gone over carefully with body putty, if necessary, and sanded smooth.

I. Unless the prime coat material to be used is recommended by its manufacturer for application over zinc-coated surfaces of the type at hand, after cleaning and any necessary de-glossing, only, surfaces must be given phosphate pre-treatment prior to application of prime coat; usual "vinegar etch" or acid pre-treatment (wash) will not be permitted.

J. Phosphate Pre-Treatment: Crystalline zinc phosphate type; either "Lithoform", made by the American Chemical Paint Co., Ambler, Pa., or Galvaprep No. 5", made by Neilson Chemical Co., Detroit, Michigan as approved. Follow manufacturer's instructions and directions exactly, as to cleaning prior to treatment, application of treatment and after-rinse.

K. Concrete Block Masonry:
   1. Prepare concrete block masonry surfaces by removing all efflorescence, dirt, rust, oil and grease stains, and method used shall be as determined by the Painting Contractor and paint manufacturer's representative. Surface must be acceptable before painting.
   2. Before first paint coat is applied, spot prime any nails and other exposed metal occurring in the surfaces with an oil base masonry primer as recommended by the paint manufacturer, to insure against rust.

L. Plaster and drywall surfaces shall be sand-papery smooth, and scratches, cracks and abrasions shall be satisfactorily eliminated before priming. Spot seal "hot spots" after first coat has dried.

M. Storage for paint materials, preparation and mixing shall be in well-lighted and ventilated central location; but shall not be allowed on finished floor. Oily rags and waste must be removed from building every night, and must not be allowed to accumulate.

N. Dropcloths shall be generously used and shall be carefully placed and secured over floor areas as the paint work progresses.

O. Adequate safeguards shall be provided against damage from the escape of materials during spray operation. Except that stains may be applied by cloth or sponge, all coatings shall be applied by brush or roller unless spray application is specifically named as acceptable, in description of required treatment.

P. All adjoining surfaces, finish floors and fixtures shall be carefully protected throughout the painting operations against spray or splash stains, marks or other damage; and should such defacement occur as a result of the work, it shall be corrected in a manner acceptable and satisfactory to the Architect and without added cost to the Owner.

Q. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
R. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

S. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
1. Mechanical Work:
   a. Uninsulated metal piping.
   b. Pipe hangers and supports.
   c. Tanks that do not have factory-applied final finishes.
   d. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
   e. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   f. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
2. Electrical Work:
   a. Electrical equipment that is indicated to have a factory-primed finish for field painting.

T. Preparation of existing exterior painted metal and prefinished surfaces shall include the following:
1. Remove all oil, grease, dirt oxides and other containments from surfaces per SSPC-SP1.
2. Clean surface area with water based cleaning solution
3. Test existing area with previously finised surfaces with new coating by applying test area of 3 square feet. Allow to dry for one week before checking adhesion.

U. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

V. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.4 WORKMANSHIP

A. All painting shall be done by skilled mechanics working under the supervision of a capable foreman and all workmanship shall be of the highest quality developing to fullest the possibilities of the materials and the processes specified.

B. Materials shall be thoroughly stirred and evenly spread without runs, skips, sags, streaks, brush marks, or other defects. Paint shall be cut sharply to lines. Care shall be exercised to avoid lapping of paint over hardware. Painting around glazed openings shall be done promptly after putty is hard, but before shrinkage checks occur and shall seal the jointing of putty to glass.

C. Do not paint over UL or FM labels.

D. Not less than 24 hours between coats shall be allowed for drying, and painting, except as otherwise specified, shall not be allowed to proceed except on thoroughly dry surfaces. All painting application shall be in accordance with manufacturer's published specifications. All doors, cabinets and millwork shall be primed upon delivery to the site with stain or paint as required. All wood working shall be backprimed before it is installed.
E. Exterior painting shall not be done during or immediately following raining or frosty weather or when the temperature is below 50°F, or likely to drop to freezing during drying. The application of treatments while surfaces are exposed to hot sun, or when temperature is above 90°F, or likely to be, during the drying period, shall be avoided.

G. In using paste wood filler on open grain wood, allow sufficient time for "set" then wipe, first across grain, then with the grain, to secure a clean surface.

3.5 PAINTING APPLICATION

A. The following are descriptions of painting applications. The manufacturer's products named below sets standard for products of other manufacturers listed under MATERIALS Paragraphs 1A and B, whose products shall be of equal to those listed below.

B. Seal coats shall be tinted to final color. The first coat applied after the seal coat or primer (or first coat on shop primed surfaces), shall be full color as should be each subsequent coat.

C. All interior and exterior work shall have a minimum of 3 coats (in addition to the specified primer). Provide additional coats as required for proper coverage. Approximately 25% of all painted areas to receive deep tint colors.

D. Where metal to be painted has not already received a shop coat, it shall be cleaned and primed as directed by the Architect.

E. The Architect reserves the right to change color before a coat is applied. Such changes if full coverage can be achieved, shall be done by the Contractor, without additional cost to the Owner.

END OF SECTION 09 90 00
SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Visual display board assemblies.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For visual display units.
   1. Include plans, elevations, sections, details, and attachment to other work.
   2. Show locations of panel joints.
C. Samples: For each type of visual display unit indicated.
D. Product Schedule: For visual display units.

1.3 CLOSEOUT SUBMITTALS
A. Maintenance data.

1.4 WARRANTY
A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 50 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

2.2 VISUAL DISPLAY BOARD ASSEMBLY

A. Visual Display Board Assembly: Field or factory fabricated.
   1. Assembly: markerboard and tackboard.
   2. Corners: Square.
   3. Width: As indicated on Drawings.
   4. Height: As indicated on Drawings.

B. Markerboard Panel: Porcelain-enamel-faced markerboard panel on core indicated.

C. Tackboard Panel: Vinyl-fabric-faced tackboard panel on core indicated.
   2. Color and Pattern: Gilford of Maine FR701 Style 2100

D. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; standard size and shape.
   1. Aluminum Finish: Clear anodic finish.

E. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.

F. Combination Assemblies: Provide manufacturer's standard exposed trim between abutting sections of visual display panels.

G. Chalktray: Manufacturer's standard; continuous.
   1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

H. Display Rail: Manufacturer's standard, extruded-aluminum display rail with plastic-impregnated-cork insert, end stops, designed to hold accessories.
   1. Size: 1 inch (25 mm) high by full length of visual display unit.
   2. Map Hooks: Two map hooks for every 48 inches (1200 mm) of display rail or fraction thereof.
   3. Flag Holder: One for each room.
   4. Tackboard Insert Color: As selected by Architect from full range of industry colors.
   5. Aluminum Color: Match finish of visual display assembly trim.
2.3 MARKERBOARD PANELS

A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with **low-gloss** finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.

1. Face Sheet Thickness: **0.021 inch (0.53 mm)** uncoated base metal thickness.
2. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
3. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

2.4 TACKBOARD PANELS

A. Tackboard Panels:  
   1. Facing: **Polyester** fabric factory laminated to 1/4-inch- (6-mm-) thick cork sheet.
   2. Core: Manufacturer's standard.

2.5 MATERIALS

A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.

B. High-Pressure Plastic Laminate: NEMA LD 3.

C. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with **surface-burning characteristics indicated**.

D. Plastic-Impregnated Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout with **surface-burning characteristics indicated**.

E. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, Gilford of Maine FR701 Style 2100; weighing not less than 13 oz./sq. yd. (440 g/sq. m); with surface-burning characteristics indicated.

F. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than 15 oz./sq. yd. (508 g/sq. m); with surface-burning characteristics indicated.

G. Hardboard: ANSI A135.4, tempered.

H. Particleboard: ANSI A208.1, Grade M-1.

I. Medium-Density Fiberboard: ANSI A208.2, Grade 130.

J. Fiberboard: ASTM C 208 cellulosic fiber insulating board.
K. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.

L. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.

M. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
2. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

C. Factory-Fabricated Visual Display Board Assemblies: Adhere to wall surfaces with egg-size adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.

END OF SECTION 101100
SECTION 102113.19 - PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes solid-plastic toilet compartments configured as toilet enclosures and urinal screens.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachment details.
   C. Samples for each type of toilet compartment material indicated.

1.3 INFORMATIONAL SUBMITTALS
   A. Product certificates.

1.4 CLOSEOUT SUBMITTALS
   A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1. Flame-Spread Index: 25 or less.
      2. Smoke-Developed Index: 450 or less.
   B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.
2.2 SOLID-PLASTIC TOILET COMPARTMENTS

A. Toilet-Enclosure Style: Overhead braced, Floor anchored.

B. Urinal-Screen Style: Wall hung.

C. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) or polypropylene (PP) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
   1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
   2. Heat-Sink Strip: Manufacturer's standard continuous, stainless-steel strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
   3. Polymer Panel Finish: One color and pattern in each room.
      a. Color and Pattern: As selected by Architect from manufacturer's full range.

D. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
   1. Polymer Color and Pattern: Matching pilaster.

E. Brackets (Fittings):
   1. Stirrup Type: Ear or U-brackets, stainless steel.
   2. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.
      a. Polymer Color and Pattern: Matching panel.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   2. Hinges: Manufacturer's standard integral hinge for solid-polymer doors.
   3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
   5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
   6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.4 FABRICATION

A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

B. Clearances: Maximum 1/2 inch (13 mm) between pilasters and panels; 1 inch (25 mm) between panels and walls.

C. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel. Locate wall brackets so holes for wall anchors occur in masonry or tile joints. Align brackets at pilasters with brackets at walls.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.19
SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Public-use washroom accessories.
      2. Custodial accessories.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples: Full size, for each exposed product and for each finish specified.

1.3 INFORMATIONAL SUBMITTALS
   A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS
   A. Maintenance data.

1.5 WARRANTY
   A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
      1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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.
2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:
   1. Description: Owner Supplied, Contractor Installed.
   2. Mounting: **Surface mounted.**

B. Paper Towel (Roll) Dispenser:
   1. Description: Owner Supplied, Contractor Installed.
   2. Mounting: **Surface mounted.**

C. Liquid-Soap Dispenser:
   1. Description: Owner Supplied, Contractor Installed.
   2. Mounting: **Vertically oriented, surface mounted.**

D. Grab Bar:
   1. Mounting: Flanges with **concealed** fasteners.
   2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
      a. Finish: Smooth, No. 4 finish (satin) on **ends and slip-resistant texture in grip area.**
   3. Outside Diameter: **1-1/4 inches (32 mm).**
   4. Configuration and Length: **As indicated on Drawings.**

E. Sanitary-Napkin Disposal Unit:
   1. Description: Owner Supplied, Contractor Installed.
   2. Mounting: **Surface mounted.**

2.3 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least **250 lbf (1112 N),** when tested according to ASTM F 446.

END OF SECTION 102800
PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Horizontal louver blinds with polymer slats.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long.

1.3 INFORMATIONAL SUBMITTALS
   A. Product test reports.

1.4 CLOSEOUT SUBMITTALS
   A. Maintenance data.

PART 2 - PRODUCTS

2.1 HORIZONTAL LOUVER BLINDS, POLYMER SLATS
   A. Flame-Resistance Rating: Comply with NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   B. Slats: Polymers that are lead free, UV stabilized, integrally colored, opaque, and will not crack or yellow; antistatic, dust-repellent treated.
      1. Width: 2 inches (51 mm)
      2. Thickness: manufacturers standard.
      3. Features:
         a. Lift-Cord Rout Holes: Minimum size required for lift cord and located near back (outside) edge of slat to maximize slat overlap and minimize light gaps between slats.
C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrail fully encloses operating mechanisms on three sides and ends.

1. Motorized Operating Mechanisms: Coordinate headrail with motorized operator requirements. Provide headrail acceptable to blind and motorized operator manufacturers and suitable for applications indicated.
2. Manual Lift Mechanism:
   a. Lift-Cord Lock: Variable; stops lift cord at user-selected position within full operating range
   b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.
   a. Tilt: Full.
   b. Tilt: Two-direction, positive stop or lockout limited at an angle of 60 degrees from horizontal, both directions.
   c. Operator: Clear-plastic wand
5. Manual Lift-Operator and Tilt-Operator Locations: Right side and left side of headrail, respectively, unless otherwise indicated.

D. Bottom Rail: Secures and protects ends of ladders and lift cords.

1. Type: Manufacturer's standard

E. Ladders: Braided cord.

F. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

G. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.

H. Colors, Textures, Patterns, and Gloss:

1. Slats: white.
2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

2.2 HORIZONTAL LOUVER BLIND FABRICATION

A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.
B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch (6 mm) per side or 1/2 inch (13 mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).

2. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.

1. Locate so exterior slat edges are not closer than 1 inch (25 mm) from interior faces of glass and not closer than 1/2 inch (13 mm) from interior faces of glazing frames through full operating ranges of blinds.

2. Install mounting and intermediate brackets to prevent deflection of headrails.

3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

B. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

C. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.

END OF SECTION 122113
SECTION 123623 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes plastic-laminate countertops.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product, including panel products and high-pressure decorative laminate.
   B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   C. Samples:
      1. Plastic laminates, for each color, pattern, and surface finish.

1.3 FIELD CONDITIONS
   A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE COUNTERTOPS
   A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, installation, and other requirements.
      1. Provide labels from WI certification program indicating that countertops, including installation, comply with requirements of grades specified.
   B. Grade: Premium.
   C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.
   D. Chemical-Resistant, High-Pressure Decorative Laminate: NEMA LD 3, Grade HGP, and as follows:
1. Laminate has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.9.5:
   a. Nitric Acid (30 Percent): Moderate effect.
   b. Sulfuric Acid (77 Percent): Moderate effect.
   c. Hydrochloric Acid (37 Percent): Moderate effect.
   d. Phosphoric Acid (75 Percent): No effect.
   e. Acetic Acid (98 Percent): No effect.
   f. Formaldehyde: No effect.
   g. Ethyl Acetate: No effect.
   h. Ethyl Ether: No effect.
   i. Phenol (85 Percent): Moderate effect.
   j. Benzene: No effect.
   k. Xylene: No effect.
   l. Butyl Alcohol: No effect.
   m. Furfural: No effect.
   n. Methyl Ethyl Ketone: No effect.
   o. Sodium Hydroxide (25 Percent): No effect.
   p. Sodium Sulfide (15 Percent): No effect.
   q. Ammonium Hydroxide (28 Percent): No effect.
   r. Zinc Chloride: No effect.
   s. Gentian Violet: No effect.
   t. Methyl Red: No effect.

E. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As selected by Architect from manufacturer's full range in the following categories:
   a. Solid colors, matte finish.
   b. Solid colors with core same color as surface, matte finish.
   c. Wood grains, matte finish.
   d. Patterns, matte finish.

F. Edge Treatment: Same as laminate cladding on horizontal surfaces.

G. Core Material at Sinks: Particleboard made with exterior glue.

H. Core Thickness: 3/4 inch (19 mm).
1. Build up countertop thickness to 1-1/2 inches (38 mm) at front, back, and ends with additional layers of core material laminated to top.

I. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.
   1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

2.3 ACCESSORIES

A. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.

2.4 FABRICATION

A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch (25 mm) over base cabinets. Ease edges to radius indicated for the following:
   1. Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.

B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

C. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.
3.2 INSTALLATION

A. Grade: Install countertops to comply with same grade as item to be installed.

B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
   1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items.
   2. Seal edges of cutouts by saturating with varnish.

C. Field Jointing: Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required.
   1. Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

D. Install countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

E. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

F. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
   1. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
   2. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c. and to walls with adhesive.
   3. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

END OF SECTION 123623
DIVISION 22 – PLUMBING

KETTERING CITY SCHOOLS
SOUTHDALE AND ORCHARD PARK ELEMENTARIES

Levin Porter Associates, Inc. Heapy Engineering
Architect Mechanical Electrical Commissioning Technology
Miamisburg, Ohio Dayton, Ohio Project No. 2019-07023

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APRIL, 2019
PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, Supplementary Conditions including Divisions 00 and 01, apply to work specified in this Division.

B. The scope of the Division 22 work includes furnishing, installing, testing and warranty of all work and complete Plumbing systems as shown on the P series drawings, and as specified in Division 22 and elsewhere in the project documents.

C. The project drawings and specifications define scope of work for the various divisions. Such assignments of work are not intended to restrict the Construction Manager in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in Division 22. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Each bidder shall inspect the project site and the premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect / Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect / Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect / Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install piping and equipment.
D. The Architect / Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect’s / Construction Manager’s decision shall be final in regard to the arrangement of equipment, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary drains and minor valves, traps and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect / Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect / Construction Manager.

1.5 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 22 Contract. Necessary work of this nature will be arranged by the Owner / Construction Manager to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Architect / Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.6 Coordination Drawings

A. The Division 23 Contractor shall prepare and be responsible for 0.25 inch scale electronic coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format with the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 23 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings and that specified ceiling heights are maintained.

1.7 Inspection
A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.8 Record Drawings

A. Maintain a separate set of prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work and within 90 days of system acceptance, these drawings shall be turned over to the Architect / Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.9 Operating and Maintenance Manuals

A. Assemble three copies each of operating and maintenance manuals for the Plumbing work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

C. Pipe pressure test reports, domestic hot water recirculating system balance report, domestic water disinfection certificate of completion and bacteriological analysis results shall also be included.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer and Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

1.10 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect the work and develop their own punch list to confirm that it is complete and finished. Then notify the Architect and Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.11 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between
Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during this warranty period shall be made good without expense to the Owner. Use of equipment for temporary system use is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and/or labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer’s recommendations.

C. This provision shall not be construed to include maintenance items such as re-tightening or repacking glands, greasing, oiling, belt tightening and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

All equipment and appliances shall be listed and labeled in accordance with the Plumbing Code. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance

2.3 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.4 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.
B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

D. If extensive changes in pipe or equipment layout, or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.5 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer’s attention in a separate clearly stated notification at the time of submittal for the Engineer’s review.

C. Shop drawings of the following Plumbing equipment and materials shall be submitted:

   1. Pipe, fittings and joining methods for the various systems.
   2. Pipe hangers and supports.
   3. Valves.
   5. Pipe insulation.
   7. Drainage system specialties.
   8. Plumbing fixtures and trim.

PART 3 - EXECUTION

3.1 Pipe Testing

A. All piping provided in this work shall be pressure tested, as specified below.

B. Pipe testing for Plumbing piping shall be:
   1. Domestic cold and hot water piping - hydrostatic at 125 psig or 1.50 times the maximum operation pressure of the system, whichever is higher, for 6 hours at the low point of the system.
   2. Soil, waste and vent piping and storm piping - rough test and final test, in conformance to Plumbing Code requirements.
   3. Interior natural gas piping - 25 psi compressed air for 4 hours.
C. Testing shall be performed prior to application of insulation. Ensure that air is vented from piping when piping is hydrostatically tested.

D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

F. Where a new pipe connects to an existing pipe, provide the following to facilitate testing, cleaning, draining and eventual shutoff service:

1. A shutoff valve in the new pipe near the point of connection.
2. A valved stub with brass plug downstream of the valve for testing of the new pipe extension. Close valve, remove handle after testing is complete. Wire handle to valve body.

3.2 Pipe Cleaning

A. Before placing each water piping system in operation, the piping system shall be thoroughly flushed out with clean water. Remove, clean and replace all strainer screens once flushing is complete. On domestic water systems, remove, clean and replace all fixture mounted strainer screens and faucet aerators after fixtures are set and connected piping is flushed thru the fixtures.

B. Refer to appropriate Sections for cleaning of other piping for normal operation.

3.3 Disinfection of Piping

A. All new and any existing domestic water piping and equipment out of service for more than 30 days shall be disinfected by a company or personnel regularly engaged in the performance of this service.

B. Fire suppression water piping supplied from a potable water system shall also be disinfected if the potable water systems, both public and private, is not protected by a double check valve assembly or reduced pressure backflow assembly.

C. Keep new systems isolated from the existing systems until after disinfection is completed and proven acceptable by bacteriological test results. Provide a service cock at the point of connection for injection of the disinfecting agent. If it is necessary to use a potable water supply in the performance of the disinfection procedures, provide temporary reduced pressure zone backflow prevention until disinfection and analysis results are complete.

D. Thoroughly flush the system, as previously described, prior to disinfection. Disinfection shall be performed in accordance with the Local Authorities prescribed method, or when a Local Authority prescribed method is not available, in accordance with AWWA C651 or AWWA C652 Standards. Disinfection shall be by means of a chlorine solution injected into the water system near the source. Each outlet shall be tested to prove presence of minimum chlorine concentration. Document that adequate levels of chlorine are present in all parts of the system. Following the appropriate retention period, flush out the system with clean water until the residual free chlorine content is equal to the level of the incoming water, but not greater than 1.5 parts per million or until approved by the Health Department.

E. Perform a bacteriological analysis of the potable water system. One test sample shall be collected from the end of the main and one from each branch. Provide certification stating the
name of the lab performing the testing, the job name, the date of the sample and results of the testing.

F. Disinfection procedures shall be witnessed or approved by the Architect, Engineer or other qualified representative, who shall present the contractor with a letter or certificate of completion. Copies of the certificate of completion and bacteriological analysis reports shall be included in the Operations and Maintenance Manuals.

3.4 Operation and Adjustment of Equipment

A. As each piping system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing water systems, tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

C. Test relief valves, air vents and regulating valves to ensure proper operation.

3.5 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect / Engineer / Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems.

C. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

END OF SECTION
PART 1 - GENERAL

1.1 The Engineer, at his sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer’s Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form. Charges are for the Engineer’s time to prepare the documents in the format stated. They are available through the Engineer’s office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor’s systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project’s name and address, the Architect’s / and / Engineer’s / and / any consultant’s name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor’s risk, and shall in no way alter the contractor’s Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer’s or its consultant’s computer software or hardware defects or errors; the Engineer’s or its consultant’s electronic or disk transmittal of data, information or documents; or the Engineer’s or its
consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer’s consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney’s fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor’s distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached “Agreement” shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION
Project: Kettering City Schools
Southdale and Orchard Park Elementary
Dayton, Ohio

Owner: Kettering City School District

Heapy Engineering Project Number: 2019-07023

Heapy Engineering Project Manager: David Madden

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider’s Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files.

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:
   a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.
   b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.
   c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.
d. That the Recipient agrees that its use of the Electronic Files is at the Recipient’s sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient’s receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agrees to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

   a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

   a. Are suitable for any other usage or purpose.

   b. Have any particular durability.

   c. Will not damage or impair the Recipient's computer or software.

   d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications.
The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient’s conversion or electronic file storage at the Recipient’s requested site, shall be at Recipient’s sole risk.

13. Recipient acknowledges:

   a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

   b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose.

   c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

   d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant’s consent may be assigned or transferred by Recipient to any other person or entity.

Provider (Name of Company): ____________________________________________

Recipient (Name of Company): ____________________________________________

Recipient Address: ____________________________________________________

Name of authorized Recipient Representative: ______________________________

Title of authorized Recipient Representative: ______________________________

E-mail address of authorized Recipient Representative: ______________________

Signature of authorized Recipient Representative: __________________________

Date: __________________________
NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. **Electronic File Format (select one):**

1. [ ] .DWG Format - List of Drawings Requested: __________________________________________

2. [ ] Revit Project Model Requested (Model only, no Views included)

B. **File Transfer Medium (select one):**

[ ] CD-ROM  [ ] DVD-ROM  [ ] Heapy FTP  [ ] User’s FTP site  [ ] Flash Drive

C. **Delivery of Electronic Files Cost Summary:**

Available Electronic .DWG file format:

[ ] 2018 DWG

If a different file version is required than the indicated available version state the requested version:

______ .DWG

**Note that an additional charge per sheet will be incurred.**

Cost of Preparation of Division 22 Electronic .DWG Files:

First Drawing: $50.00      $50.00

Additional Drawings $15.00 each _________ x $15.00 = $ ________

Conversion to .DWG version different from available .DWG:

$5.00 additional/sheet _________ x $ 5.00 = $ ________

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ ________

All files will be bound together.

Available electronic Revit file format:

[ ] 2018 .RVT

Cost of Preparation of Division 22 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ ________
PART 1 - GENERAL

1.1 Construction Water

A. Refer to Division 01 - General Requirements, for information regarding construction water.

B. Each Contractor requiring water for construction purposes shall connect to wall hydrants or other connection points within the existing building.

1.2 All piping, fittings, valves, solders, fluxes, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

1.3 Continuity of Services

A. Work shall be so planned and executed as to provide reasonably continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner and Construction Manager shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdown shall be bid as being done outside of normal working hours.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devise and equipment requiring service or adjustment. Refer to Section 22 13 19 Drainage System Specialties for access plates associated with cleanouts.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with tamperproof screws. Locks in “secured” areas of the building shall have tamperproof screws. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.
2. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls, Milcor Style “ATR” or equal.

C. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.
D. Materials used in plenums shall be rated for plenum use conforming to the 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Plumbing work shall be performed by licensed Plumbing Contractors in accordance with requirements of the jurisdiction.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect or Construction Manager. All piping and tubing shall be elevated from grade for on-site storage, and all open ends shall be covered. Plastic piping shall be protected from direct and indirect sunlight.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange for the provision of openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work. Any damage caused to the building shall be repaired or rectified.

C. Where pipes are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching and refinishing of same shall be provided. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls, etc. are to be cut for presence of existing utilities.

D. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system, brace floor or alter location of new work to maintain existing system.

E. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

F. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect / Construction Manager. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.
G. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

3.4 Removals, Alterations and Reuse

A. Refer to the project documents for the scope of remodeling in the existing building.

B. Cooperate with the General Contractor and Construction Manager regarding all removal and remodeling work. Unless otherwise noted, remove all existing work which is associated with Division 22 and which will be superfluous when the new work is installed and made operational.

C. Extraneous piping which is or becomes accessible shall be removed and stubs shall be capped at the first active pipe encountered. Piping that is and remains inaccessible shall be disconnected from active systems and abandoned. Ends of abandoned pipe shall be capped so as to be concealed by finished surfaces. Upon completion of the work no abandoned pipe, valve or stub shall extend thru finished floors, walls or ceilings.

D. When it is necessary to reroute a section of active piping the rerouted section shall be installed before removing the existing in order to minimize system down time. Rerouted sections shall be insulated as required for new work. Patch insulation on existing piping which has been damaged or removed in this work.

E. Materials and equipment which are removed shall not be reused within the scope of this project unless specifically noted to be relocated or reused. Turn over to the Owner and place where directed on the premises all removed material and equipment so designated by the Owner. All material and equipment not claimed by the Owner shall become the property of the Contractor responsible for removal and shall be removed from the premises.

F. Remove, store and reinstall lay-in ceiling tile and grid as needed to perform work in areas where such removal and re-installation is not to be done by the General Contractor. Damaged tile and/or grid shall be replaced with new matching tile and/or grid.

G. In areas of minor work where the space is not completely vacated, temporarily move portable equipment and furnishings within the space as required to complete the work. Coordinate this activity with the Owner / Construction Manager. Protect the Owner’s property by providing dust covers and temporary plastic film barriers to contain dust. Remove barriers and return equipment and furniture upon completion of the work.

H. Refinish any surface disturbed under this work to match existing, except where refinishing of that surface is included under the General Contract.

3.5 Painting

A. In addition to any painting specified for various individual items of equipment, provide the following painting:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.

2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.

3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. 221 cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 Specifications. All rust must be removed before application of paint.

C. Provide finish painting only where specifically instructed. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.6 Access Panels

A. Install access panels. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall. Provide appropriate framing with drywall beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

END OF SECTION
PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and pipe layouts.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the OBC and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer’s engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer’s specifications and technical data of each material, documentation of UL firestopping assemblies and installation instructions. Submittals shall include all information required in the OBC.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Rectorseal-Metacaulk, Tremco, Nelson, Specified Technologies or other approved manufacturer.

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer’s instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 22 05 07 Piping Materials and Methods for Plumbing for pipe sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION
PART 1 - GENERAL

1.1 Piping materials and methods for piping common to Division 22 – Plumbing shall be as specified herein and as shown on the drawings.

1.2 All piping, fittings, valves, solders, fluxes, seals and appurtenances in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

1.3 Included in this section are:
   A. Pipe, fittings and joining methods.
   B. Unions and flanges.
   C. Dielectric connectors.
   D. Pipe sleeves, openings, curbing and escutcheons.
   E. Installation methods of piping.

1.4 Refer to other Sections in Division 22 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.5 Refer to Section 22 05 05 Firestopping and Division 7 for firestopping requirements.

1.6 Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.


1.8 Pipe threads shall meet B1.20.1 for factory threaded pipe and pipe fittings.

1.9 Soldering procedures per ASTM B828 with flux per ASTM B813 and solder per ASTM B32.

1.10 Solvent cement joints for PVC per ASTM D-2855, primer per ASTM F656.

1.11 Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to this trade in new walls, partitions, floors and roof slabs, same as for new piping.

1.12 Pipe sleeves shall be provided where below grade pipes penetrate foundation walls. Relieving arches shall be provided for all below grade pipes passing below structural footings.

1.13 Sleeves are not required:
   A. In floor slabs on grade.
   B. In stud and gypsum board or plaster walls and partitions which are not fire rated.
C. For above grade uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.

1.14 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 Copper tubing, conforming to ASTM B88, Standard Specification for Seamless Copper Water Tube and Fittings and Joints, shall be:

A. Type C1
   Pipe - Type "L" seamless hard drawn copper tubing.
   Fittings – ASME B16.22 wrought copper or cast bronze, solder ends.
   Joints - soldered with lead-free tin alloy, 95-5 tin-antimony or silver-bearing tin in accordance with methods of ASTM B828 and equal to Harris "Stay-Brite", "Stay-Brite 8" or "Bridgit".

B. Type C6
   Pipe - Type "L", 0.5 inches thru 4 inches seamless hard drawn copper tubing.
   Fittings – copper or cast bronze press fittings conforming to ASME B16.51 and ASME B16.22, EPDM O-ring seal. O-ring seal and/or seal cup design must not allow the fitting joints to pass a pressure test prior to being pressed.
   Joints – 200 psi, 250 degrees F rated compression joint using fitting manufacturer approved electro-hydraulic crimping tool. Compression crimp shall be applied on upstream and downstream side of EPDM seal bead.

C. Mechanically formed extruded outlets in copper tubing may be provided in lieu of standard tees and couplings. Mechanically formed extruded outlets shall be in compliance with ASME B31.9, Section 930.2, constructed perpendicular to the axis of the run tube and formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height three times the thickness of the branch wall. The inner branch tube end shall conform to the shape of the inner curve of the run tube, and the insertion depth shall be controlled so that the branch tube does not extend into the flow stream. All joints shall be brazed. All installation tools and procedure shall be by a single manufacturer. Mechanically formed tees and couplings shall be T-Drill or approved equal.

2.2 Unions and flanges shall be:

A. Unions on copper tubing, all bronze construction 150 lb., solder ends.

B. Unions on steel pipe 2 inches and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

C. Flanges on steel pipe with welded or screwed joints, 2.50 inches and larger. Gaskets shall be 0.0625 inch thickness, ASME B16.21, full face compressed sheet suitable for temperature and pressure ranges of the application.

D. Unions on plastic pipe, same composition and pressure rating as the piping system.

2.3 A dielectric connector shall be incorporated at each connection between ferrous and non-ferrous piping. Connectors shall be:

A. Dielectric coupling with non-conductive polymer liner, Victaulic Style 47, Gruvlok “Di-Lok” and Lochinvar Corp. “V-Line” Dielectric fitting on services 200 degrees and less, and pressures less than 300 psi.
B. Dielectric flange kits with non-metallic bolt hole grommets and gasket by Watts, Drake Specialties, Corrosion Control Products Company or Advance Products and Systems.

2.4 Pipe sleeves shall be:

C. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

2.5 Piping and conduits extending thru the roof may be fitted with a manufactured pipe curb weatherproofing assembly equal to Pate pca and mpca or equal by Roof Product Systems or Thybar, as an alternative to riser sleeves with clamping rings specified above.

2.6 Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Mechanically formed tee fittings and couplings of the T-Drill type on copper tubing shall be formed in a continuous operation using equipment specifically designed for the application in strict adherence to the manufacturer’s instructions. Cutting debris shall be removed from the piping on completion. Joints shall be brazed.

3.3 Press connections: Copper press fittings shall be made in accordance with the manufacturers installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing if fully engaged (inserted) in the fitting. The joints shall be made using a calibrated tool approved by the manufacturer.

3.4 Piping shall be pitched for drainage. The low points shall be fitted with a 0.75 inch drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1.25 inches and smaller where a drain valve is not shown, a drain plug is acceptable.

3.5 Piping shall be installed consistent with good piping practice, run concealed wherever possible and located as to be protected from damage by freezing. Coordinate with other trades to attain a workmanlike installation.

3.6 Piping shall be supported as specified in Section 22 05 29 Hangers and Supports for Plumbing Piping. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.

3.7 Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering.

3.8 Installation of plastic piping shall be in full compliance with manufacturer's recommendations and code requirements, with specific consideration given to expansion compensation and pipe hanger spacing. Plastic pipe is not permitted in air plenum spaces.

3.9 Close open ends of piping during installation to keep interior of the pipe clean.

3.10 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the NEC.
3.11 Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection purposes.

3.12 Pipe sleeves shall be placed, and structural footing relieving arch requirements shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect.

3.13 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water, refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.14 Refer to 22 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.15 In lieu of firestopping and where permitted by the OBC, uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar) in compliance with ASTM E 119 test requirements.

3.16 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with sealant or caulking to retard the passage of noise or smoke. Sealant or caulking shall be applied per the manufacturer’s requirements, including opening width limitations, backing materials, sealant or caulking thickness, etc. Sealants and caulking shall be compatible with the materials they are in contact with, and sealants and caulking in direct contact with copper piping shall be silicon-based to minimize the potential for corrosion.

END OF SECTION
PART 1 - GENERAL

1.1 Excavate for all in-grade underfloor piping, underground exterior piping and associated incidental work. Backfill to finish grade or to levels consistent with site work activity. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition or as is consistent with site activity. Cut existing floor slabs and replace slabs in conformance to 22 05 04 Basic Plumbing Materials and Methods. All work shall comply with requirements set forth in Division 31 – Earthwork and Division 32 – Exterior Improvements.

1.2 Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.

1.3 Contact the Ohio Utilities Protection Service (1-800-362-2764 or 811) and the Oil and Gas Producers Underground Protection Service (1-800-925-0988 or 811) sufficiently in advance of the start of any excavation so that notification can be made to member utility departments and utility companies (water, sewer, gas, petroleum, electric, telephone, cable, etc.) having underground utilities in or near the project area. Also contact those companies to verify that utility lines have been located and duly marked and identified.

1.4 A utility locator service shall be provided to locate, mark and identify private lines and other utilities that are not located by the means mentioned above.

1.5 Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by this Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 Refer to Division 31 Earthwork for bedding and backfill materials specifications.

PART 3 - EXECUTION

3.1 Trenches for interior and exterior piping shall be over excavated and the pipe shall be laid on 6 inches minimum depth sand bed.

3.2 Backfilling and compaction of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with approved backfill materials, to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand.

3.3 Backfill shall be mechanically compacted in layers not over 6 inches deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of. Refer to Division 31 Earthwork for compaction requirements.

3.4 Plastic piping for sewers and drain shall be installed in compliance with ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-flow Applications.

3.5 Concrete floor slabs, paving, sidewalks, curbs, sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced by this Contractor equal to original conditions. Refer to Division 32 for Exterior Improvement
requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.

3.6 Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadway shall be included so that no additional cost will accrue to the Owner.

3.7 Maintain in place adequate barricades, guards, planking, plating, signage, warning lights, etc., at and around excavations.

3.8 All exterior underground piping shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6 inches wide with black letters identifying the piping service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18 inches above and on the centerline of the pipe.

END OF SECTION
PART 1 - GENERAL

1.1 Refer to Section 22 11 16 Interior Domestic Water Piping and Section 22 11 19 Interior Domestic Water Piping Specialties for selection of valves for the various services. Valves peculiar to individual systems are referenced or specified in Sections related to those systems.

1.2 Valves and materials shall comply with applicable standards and specification of ANSI, ASTM, ASME and MSS. Working pressure and temperature ratings of each valve shall exceed those imposed by the service in which it is applied.

A. ASTM B584 and ASTM B61 Copper Alloy Sand Casting for General Applications.

B. MSS SP-80 Bronze Gate, Globe and Check Valves.

C. ASME B16.34, MSS SP-110 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

D. Bronze (brass) valves installed in drinking water systems made with copper silicon alloy shall contain less than 22 percent zinc, and made with copper bismuth alloy less than 4 percent zinc. Bronze (brass) valves installed in non-drinking water systems shall contain less than 15 percent zinc.

1.3 All piping, fittings, valves, solders, fluxes, seals, fixtures, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the "Lead Free" requirements of NSF 61 Annex G and NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Valves installed in potable and drinking water systems shall be:

A. Ball Valves – NIBCO, Apollo, Milwaukee, Watts, Legend

   1. Type B1. 2 inches and smaller.
      NIBCO T 585-66-LF, 150 s.w.p., 600 w.o.g., two-piece bronze body, ASTM B584 screwed ends, full port, stainless steel ball and stem, packing nut with adjustable stem packing, TFE seat and seal, handle.

2.2 Sweat end valves of equal construction and features are acceptable in lieu of those specified with screwed ends.

2.3 Ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation. On cold service piping, the extended shaft neck design shall permit operation of the valve without breaking the vapor seal.

PART 3 - EXECUTION

3.1 Drain valves shall be the same as for shutoff service. Provide a 0.75 inch hose thread adapter on the outlet of each drain valve that is not piped to a drainage point.

3.2 Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing.

3.3 Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.
3.4 Packing glands shall be tightened before placing the valves in service.

END OF SECTION
PART 1 - GENERAL

1.1 All interior and exterior piping shall be supported from the building structure.

1.2 All products and assemblies installed with-in a plenum shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other approved equal manufacturers are B-line, Erico, Mason, PHD and TOLCO.

2.2 Hangers and supports for horizontal piping shall be equal to:

A. General service - clevis type - Anvil Fig. 260.

B. Uninsulated copper tubing - copper plated clevis type - Anvil Fig. CT-65 (or plastic coated clevis).

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis and trapeze type hanger.

<table>
<thead>
<tr>
<th>Pipe Sizes</th>
<th>Min. Rod Dia.</th>
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<tbody>
<tr>
<td>2” and smaller</td>
<td>0.375”</td>
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<tr>
<td>2.5” to 3”</td>
<td>0.50”</td>
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<tr>
<td>4” to 5”</td>
<td>0.625”</td>
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<tr>
<td>6” to 8”</td>
<td>0.75”</td>
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2.4 Where the length of the hanger rod between the top of the hanger and the attachment device is 3 inches or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel.

2.5 Hanger rod attachment devices for attachment to the structure shall be:

A. After-set steel expansion type concrete inserts.

B. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

C. Channel support systems equal to Unistrut or Hilti.

D. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.6 Pipe riser supports shall be as follows:

A. Riser clamps on cold service piping (cold water, chilled water, etc.) - insulated pipe riser clamp assembly, Pipe Shields, Inc. E1000, with polyisocyanurate insulation, galvanized steel jacket, top thrust plates and riser clamps.
B. Riser clamps on piping other than cold service - Anvil Fig. 261 except, on copper tubing, CT-121 (copper plated) or CT-121C (plastic coated).

2.7 Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension. Piping 1” and smaller and specified to be insulated with elastomeric type insulation may utilize Anvil’s 25/50 flame/smoke rated Klo-Shure strut-mounted TPO plastic insulation couplings with steel strut clamp. Insulation wall thickness shall be 0.75” thickness. Transition to required service insulation thickness within 2” of either side of coupling.

2.8 Pipe supports for pipe and conduit running across the roof shall be molded polycarbonated pillow block, UV stabilized polypropylene, 100% recycled UV-resistant rubber, or electro-galvanized metal over polyethylene foam block pipe stands. Manufactured by Miro Industries, ABI Inc., Erico, Mifab or Anvil H-Block. Pipe supports adjustment to compensate for roof slope shall be an integral part of the support design. Pipe supports shall require no penetration of roofing membrane. Associated metallic hardware shall be hot dipped galvanized. Furnish protective slip sheets of roofing membrane for installation under bases.

2.9 Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, provide sheet metal shields and insulation inserts as specified in 22 07 19 Plumbing Piping Insulation.

2.10 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.11 Coordinate the items above during the bidding period and determine, consistent with industry practice, the selection, furnishing and installation of the needed components.

PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as follows; unless otherwise shown on drawings:

A. Steel pipe (vertical) - at the base, at each floor level, and 15 ft. maximum spacing.
B. Steel pipe (horizontal) - 7 ft. intervals for piping 1.5 inches size and smaller, 10 ft. spacing for piping 2 inches thru 6 inches, 12 ft. spacing for larger pipe.
C. Copper tubing (vertical) - at the base, at each floor level; and 10 ft. maximum spacing.
D. Copper tubing (horizontal) - 6 ft. spacing for tubing 1.25 inches size and smaller, 8 ft. spacing for 1.50 inches thru 2.5 inches sizes, 10 ft. spacing for tubing 3 inches size and larger.
E. Cast iron pipe (vertical) - at the base and at each floor (15 ft. maximum spacing).
F. Cast iron pipe (horizontal) - at each fitting and at each joint on straight lengths, 10 ft. maximum spacing.
G. Plastic Pipe - spacing and hanging methods in strict accordance with code requirements and manufacturer’s recommendations, with consideration being given to service temperature and expansion compensation, but no greater than 4 feet spacing for horizontal and no greater than 10 feet spacing for vertical piping (with midstory guide).

3.2 Attachment of pipe hangers to the structure shall be with:

A. After-set concrete inserts, in 4 inches minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.
B. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment. Attachment to bar type joists shall be at joist panel points only.

C. In fabricated steel joist construction (bar joists) attachment of hanger rods shall be through the gap of the joist chord angles so that loads are concentrically applied to the steel joist in accordance with the rules of the Steel Joist Institute and the Architect. Connections made to the outer edge of one chord angle shall be limited to loads less than as approved by the Architect.

D. Unistrut type channel support system may be utilized where a number of pipes are run parallel or to span below other utilities and equipment. Channel shall be pre-set or attached to the structure with inserts or clamps.

E. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

F. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

3.3 Pipe supports manufactured by Miro Industries / Mifab / Advanced Support Products / Anvil H-Block for pipe running across the roof shall be installed in accordance with the manufacturer’s instructions and as detailed. Install protective slip sheets of roofing membrane under the bases to satisfy requirements of both the roofing manufacturer and the support system manufacturer.

3.4 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.5 Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within the pipe chase. Ensure that adequate support is still maintained.

3.6 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.7 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

A. MSS SP-58 on Materials, Design and Manufacturer
B. MSS SP-69 on Selection and Application
C. MSS SP-89 on Fabrication and Installation Practices

END OF SECTION
22 05 53    IDENTIFICATION OF PLUMBING PIPING

PART 1 - GENERAL

1.1 Identification of plumbing equipment shall consist of pipe marking and valve tagging as specified hereinafter.

1.2 Pipe markings shall be applied to all piping.

1.3 Underground exterior piping shall be identified with a continuous plastic line marker tape as described in the service piping sections and this section.

1.4 Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8.50 inches x 11 inches paper, tabulating valve number, piping system, system abbreviation, location of valve (room or area) and service (e.g. - south wing cold water).

1.5 Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

1.6 Coordinate pipe markings and valve tags to ensure similar markings.

PART 2 - PRODUCTS

2.1 Pipe markings shall be:

   A. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl markers similar to the above.

   B. Non-metallic piping that is insulated for plenum rating purposes shall be labeled with White letters on Brown background. Labeling shall state “Insulation Required for Plenum Rating – Do Not Remove.”

   C. On piping and insulation 6 inches and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1.50 inches wide, full circle at both ends of the marker.

   D. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.2 Underground line marker tape shall be permanent bright-colored, plastic with continuous identification lettering. Tape over service lines that cannot be detected by a metal detector shall be multi-ply with an aluminum foil core.

2.3 Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with “P” (for plumbing) and the designated number.

2.4 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after insulation and painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in Division 22 identification work, with corresponding designations shown, specified or scheduled on drawings.
3.3 The Division 21, 22 and 23 labeling, marking and tagging shall be coordinated and consistent with systems of identification.

3.4 Pipe markers shall be placed:
   A. At each piece of equipment.
   B. At 25 ft. centers in mechanical rooms and concealed spaces.
   C. At 50 ft. centers in exposed finished area locations.
   D. On mains at each branch take-off.
   E. At least once in each room.

3.5 Refer to appropriate sections of this specification for installation of underground line marker tape.

3.6 Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above. Copies of one set of schedules shall be framed under glass or plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION
PART 1 - GENERAL

1.1 Piping systems shall be insulated as described below. Pipe, fittings, unions, flanges, valves, devices, specialties and related items in the piping systems shall be insulated unless otherwise noted, with access maintained to P/T test ports, strainer caps, air vents and similar accessories thru the use of removable and reusable caps, plugs and fittings.

1.2 Composite insulation assemblies shall not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 243 listed in lieu of UL 8723 or ASTM E84.

1.3 Insulation thicknesses are based on ASHRAE 90.1 and an average thermal conductivity of 0.22 to 0.28 BTU-in./hr. ft. at 100 degrees F (0.21 to 0.27 BTU-in/hr ft at 75 degrees F). Thickness of insulation with lower conductivity may be reduced proportionately except that minimum thickness shall be 0.50 inch.

1.4 The following plumbing piping shall be covered with insulation of thickness listed, in compliance with ASHRAE 90.1, latest publication:

<table>
<thead>
<tr>
<th>Pipe System</th>
<th>0.75” and smaller</th>
<th>1.0” to 1.25”</th>
<th>1.50” to 3”</th>
<th>4” to 6”</th>
<th>8” and larger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic cold and non-potable water</td>
<td>0.50”</td>
<td>0.50”</td>
<td>1”</td>
<td>1”</td>
<td>1”</td>
</tr>
<tr>
<td>Domestic hot water (≤140°F)</td>
<td>1”</td>
<td>1”</td>
<td>1.50”</td>
<td>1.50”</td>
<td>1.50”</td>
</tr>
</tbody>
</table>

1.5 Insulation on plumbing systems is to be omitted on the following:

A. Unions in domestic hot water piping systems.

B. Exposed plumbing fixture supplies and supply stops except where required to meet ADA requirements.

C. Exposed chrome plated piping and pipe line devices in kitchens, laboratories, etc.

D. Vertical interior storm drainage piping (downspout), except the first vertical section at the outlet of the roof drain sump and as noted above.

1.6 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.7 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage in addition to storing in original wrapping.

PART 2 - PRODUCTS
2.1 Fiberglass insulation shall be manufactured by Johns Manville, Owens-Corning, Knauf or Manson. Closed-cell elastomeric insulation shall be manufactured by Armacell, K-Flex USA “Insul-Tube” or Aeroflex USA “Aerocel-SSPT”. Refer to paragraphs below for manufactures of specific restricted use insulations.

2.2 Fiberglass pipe insulation shall be factory molded tubular fiberglass with "all service" jacket having an integral vapor barrier. Longitudinal joints of the jacket shall be overlapping with factory applied adhesive. In lieu of the factory adhesive, staples on 6 inch centers may be used with vapor barrier mastic applied to seal both the joint and stable holes. Butt joints shall be sealed with 3 inches wide ASJ pressure sensitive tape. Insulation shall be GreenGuard certified for low formaldehyde and VOC emissions.

2.3 Closed-cell elastomeric insulation shall be tubular or sheet form, flexible pipe insulation. Polyolefin insulation is not acceptable. Insulation shall be manufactured without the use of CFC’s, HCFC’s or HFC’s. It should meet ASTM C534 and also be formaldehyde free, low VOC and resistant to mold and mildew. Pre-slit longitudinally with pressure sensitive adhesive tape closure system on tubular systems up to 4 inches IPS pipe size, field-split adhesive-seal on tubular systems for 6 inches IPS pipe size and self-adhering sheet insulation for pipe sizes larger than 6 IPS. Joints which do not have factory-applied sealant shall be sealed with 2 inches wide elastomeric thermal insulation tape or low VOC vapor sealing adhesive, complying with the specifications of the insulation manufacturer. Installation shall be in accordance with the manufacturer’s published installation instructions.

For indoor systems, use shall be restricted to those systems requiring 1.5 inch thickness or less (due to 25/50 ASTM E84 requirements).

Unless jacketed, for insulation located outside, field paint with minimum (2) coats of an appropriate paint as recommended by the insulation manufacturer to prevent solar ultra-violet deterioration.

2.4 Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with:

A. For fiberglass insulation systems:
   1. Factory molded fitting insulation cover with PVC one-piece fitting cover;
   2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover;
   3. Fiberglass blanket insulation, compressed, held in place and covered with PVC one-piece fitting cover; or
   4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.

B. For closed-cell elastomeric insulation systems:
   1. Miter cutting of tubular insulation using special tools and mitering devices; or
   2. Oversized pipe insulation and insulation donuts, overlapped and shaped to conform to the fitting, valve or device.

2.5 Hangers on insulated horizontal piping are to be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:

A. Pipe 2 inches and smaller - Anvil Fig. 168 18 ga. sheet metal rib-lock shield with belled ends, 12 inches long.

B. Pipe 2.50 inches and larger.
   Pipe service temperatures 210 degrees F and below: minimum 12 inches long, 360 degrees insulated saddles equal to Buckaroos Tru-Balance with phenolic foam insulation, integral zero-perm vapor barrier and sheetmetal rib-lock shield with belled ends. For piping systems
specified to be insulated with elastomeric type insulation, utilize Armafex IPH 25/50 flame/smoke rated insulation pipe hangers with polyurethane inserts and 30 MIL aluminum jacket, insulation wall thickness shall be minimum 1”. If required service insulation is specified to be greater than 1”, transition to required thickness within 2” of either side of IPH.

2.6 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.7 Protective jacketing on fiberglass insulation for both pipe and fittings shall be 0.016 inch aluminum with special Z-joint closure and factory supplied snap-straops.

2.8 Removable reusable covers for hot water accessories such as automatic flow controllers and balancing valves shall be insulated type with a factory fabricated removable and reusable cover. Insulation shall have a minimum k-factor .26, using fiberglass blanket. Flame and smoke spread for the assembly shall meet 25/50 per ASTM E-84. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined by tabs made from hook and loop fasteners (Velcro). Butt ends shall have sewn-in-place elastic. Outer jacket shall overlap adjoining sections of pipe insulation. Installation shall not require the use of any special hand tools. Removable re-usable covers shall be manufactured by No Sweat Valve Wraps, Inc., or approved equal.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers’ recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping and fittings has been completed prior to installation.

3.3 Installation

A. Installation shall be done by tradesman specializing in insulation work in strict accordance with manufacturers’ recommendations. Installers shall be factory trained and certified for the insulation systems being installed. Submit credentials upon request.

B. Install all insulation materials and accessories in accordance with manufacturer’s published instructions and recognized industry practices.

C. Install insulation on piping subsequent to installation of heat tracing and acceptance tests.
D. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal, including over staples.

E. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic, except in cellular glass systems. PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.

F. Vapor barrier shall be continuous on insulation of all cold services, including horizontal storm and overflow drains. Vapor barrier type mastic shall be used where needed to maintain a vapor seal. Overlap and seal all longitudinal joints of fiberglass insulation jacket. Staples and adhesive may be used as stated above. Tape and seal cross joints.

G. Insulation on cold service piping shall be run thru floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to the 22 05 07 Piping Materials and Methods for special considerations which must be given at fire rated wall and floor penetrations. Refer to Section 22 05 23 General Duty Valves for Plumbing Piping for valves requiring extended shaft necks. Coordinate the furnishing, installation and detailed requirements of these. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.

H. The underside of roof drain sumps / bearing pans shall be insulated with self-adhering sheet form closed-cell elastomeric insulation, securely adhered to the underside. All joints shall be adhesive sealed, vapor-tight, to minimize the potential for condensation forming. Blanket type fiberglass insulation shall not be used.

I. Protective jacketing shall be applied over insulation on piping, fittings, valves and devices as specified above. All joints and seams of the jacket located outside shall be sealed watertight.

3.4 Protection

A. Advise as to the requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.6 Reinsulate piping to match where existing insulation has been damaged or removed in the performance of work in this project.

END OF SECTION
PART 1 - GENERAL

1.1 Piping, valves and associated devices and materials for the interior fuel gas system shall be provided as shown on the drawings and as specified.


1.3 Refer to 22 05 07 Piping Materials and Methods for Plumbing, 22 05 23 General Duty Valves for Plumbing Piping, 22 05 29 Hangers and Supports for Plumbing Piping and other appropriate sections for applicable provisions relating to work in this Section.

PART 2 - PRODUCTS

2.1 Gas piping in all areas of the building shall be Schedule 40 black steel ASTM A-53 Types E and F. Fittings shall be steel welding type and threaded malleable iron or consistent with joint requirements. Joints shall be welded except that threaded joints are permitted:

A. On threaded valves and unions.

B. At final connections to equipment.

C. On piping 2 inches and smaller carrying gas at 1 psi and less. Refer to Paragraph 3.1.

2.2 Shutoff valves shall be:


B. Ball valve. Hammond, Nibco, Milwaukee, Watts, Apollo. 2 inches and smaller. Hammond 8901, 600 psi non-shock WOG, two-piece forged brass body, screwed ends, brass stem and ball with chrome plating, reinforced TFE seat and seal, handle.

C. Provide a handle with each valve.

2.3 Pipe hangers shall be provided as specified in 22 05 29 Hangers and Supports for Plumbing Piping. Unions, flanges, pipe sleeves and firestopping shall be provided as specified in 22 05 07 Piping Materials and Methods for Plumbing.

PART 3 - EXECUTION

3.1 Valves, unions and threaded joints are not permitted in inaccessible concealed locations. Valves shall not be located in ceiling air plenums and other air plenums or ducts.

3.2 A shutoff valve and a dirt and moisture leg with screwed end cap shall be provided on the pipe drop to each item of equipment.

3.3 Purging of fuel gas piping shall be conducted in accordance with the criteria and procedures outlined in the International Fuel Gas Code for the opening of existing piping systems and/or the placing of new or revised piping systems in operation.

END OF SECTION
PART 1 - GENERAL

1.1 Piping, valves and associated devices and materials for interior domestic cold water and hot water systems shall be provided as shown on the drawings and as specified.

1.2 Refer to Section 22 05 07 - Piping Materials and Methods for Plumbing, Section 22 05 23 – General Duty Valves for Plumbing Piping, Section 22 05 29 Hangers and Supports for Plumbing Piping and other related sections for required provisions.

1.3 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Water piping and associated devices, materials and accessories shall be as described in Section 22 05 07 Piping Materials and Methods for Plumbing. Piping shall be:

A. All piping 4 inches and smaller unless specifically noted below - Type C1, Type C6. Mechanically formed extruded outlets shall be permitted.

B. Pipe nipples extending out of the wall to connect fixtures - brass with screwed ends. Exposed piping shall be chrome plated.

2.2 Valves for the various services shall be as listed below and as described in Section 22 05 23 General Duty Valves for Plumbing Piping.

A. Shutoff
   1. Ball B1

PART 3 - EXECUTION

3.1 Installation shall conform to provisions in Section 22 05 07 Piping Materials and Methods for Plumbing and Section 22 05 29 Hangers and Supports for Plumbing Piping.

END OF SECTION
1.1 Water system specialties shall be provided as shown on the drawings and as specified.

1.2 Refer to 22 05 07 Piping Materials and Methods for Plumbing, 22 05 23 General Duty Valves for Plumbing Piping and 22 11 16 Interior Domestic Water Piping.

1.3 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Point-of-Use Thermostatic Mixing Valves

A. Point-of-use mixing valves shall be designed to thermostatically blend hot and cold water for sink and lavatory supply. Valve construction shall be solid brass or bronze, with corrosion-resistant internal actuation components, union ends, and integral check valve and removable strainer on each inlet. Temperature control knob (field adjustable from 80 to 120 degrees F) shall have an adjustable stop and vandal-resistant locking mechanism. Unit shall be ASSE 1070 listed.

B. Valves serving individual faucets shall control to a minimum flow of 0.5 GPM and have a maximum 5 PSI pressure drop at 2.0 GPM. Valves shall have 0.375 inch compression, or 0.5 inch union-threaded or union-sweat connections.

C. Point-of-use mixing valves shall be Powers, “Hydorgard” Series LM495 or equal by Apollo, Bradley, Cash Acme, Leonard, Wilkins or Watts.

PART 3 - EXECUTION

3.1 Thermostatic mixing valves shall be installed in accordance with the manufacturer’s recommendations and details on the drawings.

END OF SECTION
PART 1 - GENERAL

1.1 Interior drainage and vent systems including soil, waste and vent system, and storm drainage system shall be provided as shown on the drawings and as specified.

1.2 Refer to 22 05 09 Excavation Backfill and Surface Restoration, 22 05 07 Piping Materials and Methods for Plumbing, 22 05 29 Hangers and Supports for Plumbing Piping and other related sections for provisions affecting this Section.

1.3 All referenced standards shall be of the latest edition adopted by the jurisdiction unless specifically noted otherwise.

1.4 All cast iron drainage and vent pipe, fittings and joining materials shall be listed to the respective standard(s) stated below, and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

PART 2 - PRODUCTS

2.1 Interior soil, waste and vent piping.

A. Pipe in grade below the floor slab shall be Schedule 40 PVC, ASTM D2665. Fittings shall be drainage type, ASTM D2665. Joints shall be solvent welded ASTM D 2564. Primer shall meet ASTM F656.

B. Pipe, fittings and joints above grade shall be:

1. Pipe shall be coated cast iron, centrifugally cast with hubless ends, ASTM A-888 and CISPI 301. Fittings shall be drainage type with hubless ends. Joints shall be made with no-hub couplings consisting of a neoprene gasket, ASTM C564, Series 300 stainless steel shield and stainless steel band, CISPI 310, NSF certified and marked. PVC piping shall not be installed in ceiling air plenums.

2. Schedule 40 PVC pipe, ASTM 2665. Fittings shall be drainage type with socket ends. Joints shall be solvent welded. PVC piping shall not be installed in ceiling air plenums.

3. Threaded nipples for fixture drain stub-outs shall be Schedule 40 PVC or copper, as specified above, with threaded adapters. Black or galvanized steel pipe is not permitted.

2.2 Storm Drainage Piping

A. Pipe in grade below the floor slab shall be Schedule 40 PVC, ASTM D2665. Fittings shall be drainage type, ASTM D2665. Joints shall be solvent welded ASTM D2564. Primer shall meet ASTM F656.

B. Pipe, fittings and joints above grade shall be:

1. Pipe shall be coated cast iron, centrifugally cast with hubless ends, ASTM A-888 and CISPI 301. Fittings shall be drainage type with hubless ends. Joints shall be made with no-hub couplings consisting of a neoprene gasket ASTM C564, and type 304 corrugated stainless steel shield and clamp assembly, ASTM C1540 complaint. No-hub couplings shall be Ideal “Heavy Duty HD”, Clamp-All 125, or Husky “SD 4000”.

2. Schedule 40 PVC pipe, ASTM 2665. Fittings shall be drainage type with socket ends. Joints shall be solvent welded. PVC piping shall not be installed in ceiling air plenums.

2.3 Floor drain traps shall be same material as the connecting piping.

PART 3 - EXECUTION
3.1 Cut pipe to required length and ream ends to remove burrs. Align horizontal piping to attain even pitch, minimum of 0.25 inch per ft. on sizes 2.50 inches and smaller, 0.125 inch per ft. on sizes 3 inches and larger unless specifically noted on drawings.

3.2 Trenching, bedding and backfill for piping in grade below floor slab shall be in accordance with 22 05 09 Excavation, Backfill and Surface Restoration.

3.3 Piping shall not be run above electrical switchgear or panelboards, nor above access space in the immediate vicinity of the equipment, in accordance with N.E.C. Article 110.26.

3.4 The use of sealers or sealants for couplings in No-Hub cast iron systems is not acceptable unless specifically recommended by the coupling manufacturer. No-Hub type couplings shall be installed in strict conformance with manufacturer’s recommendations.

3.5 Piping in air plenums shall not exceed maximum flame spread of 25 and smoke development of 50 as established by NFPA 255 test methods.

3.6 Horizontal above grade cast iron piping, in sizes 5 inches and larger, shall be braced to prevent horizontal movement and joint separation at each branch opening and change of direction. Bracing methods shall be as recommended by pipe manufacturer’s installation instructions and the Cast Iron Soil Pipe Institute (CISPI) Handbook.

3.7 Provide hangers on plastic piping at closer spacing than that for metal piping, in accordance with manufacturers recommendations. Plastic piping systems shall be installed in strict conformance with manufacturer’s latest installation instructions.

3.8 When transitioning, below floor, non-plenum rated waste or storm pipe to above floor, plenum rated material, extend to a maximum 1 ft. above finished floor. Transition to plenum rated piping and continue with plenum rated material in wall and above ceiling.

3.9 Vent piping shall extend thru the roof to at least 12 inches above the roofline. The pipe penetration shall be flashed and made watertight.

3.10 Provide cleanouts in drainage piping as indicated on the drawings and:

A. In horizontal piping at intervals no greater than 100 ft.

B. At the base of each soil and waste stack and at the base of each downspout.

C. Above each sanitary cross.

D. In sanitary and storm piping leaving the building for cleanout and testing purposes.

3.11 Maintain a minimum 4 inches backfill depth between the top of the pipe and bottom of the floor slab for all piping installed in grade below the floor. Installation, bedding and backfill for plastic pipe shall conform to ASTM D2321.

END OF SECTION
PART 1 - GENERAL

1.1 Drainage systems specialties shall be as shown on the drawings and as specified.

PART 2 - PRODUCTS

2.1 Floor drains and roof drains shall be as shown and scheduled on the drawings. Drains shall be equal to listed catalog numbers, type, size, materials and features. Drains shall be manufactured by J.R. Smith, Wade, Josam, Watts, Mifab or Zurn.

2.2 Carriers for Wall Hung Fixtures

A. Closet chair carriers, ASME A112.6, shall be adjustable type, cast iron and steel construction, with neoprene gasket, floor plate, anchor foot assembly and rear anchor tie down. Wax gaskets are not acceptable. The nipple shall be adjustable without cutting or defacing the wall and yet maintain a tight joint. Closet chair carriers shall be capable of supporting a 500 lb. load.

B. Closet chair carriers shall be so selected and installed that the stud plate is tight against the back of the wall to afford a rigid mounting. Closet chair carrier configurations and auxiliary inlets shall be provided to comply with the piping configurations shown on the drawings. Plastic or metal positioning frames shall be furnished with closet chair carriers to separate the bolts from the wall construction.

C. Lavatory chair carriers, ASME A112.6, shall be concealed arm/hanger plate type, steel construction, welded footplates, adjustable positive mechanical locking device, designed for thin wall construction. Lavatory chair carriers shall be capable of supporting the lavatory with a 250 lb. vertical load applied to the front of the fixture.

D. Plumbing fixture carriers shall be provided for all wall hung fixtures, unless specifically noted otherwise, and shall be of the same manufacturer as floor and roof drains.

2.3 Cleanouts

A. Cleanouts shall be of the same manufacturer as floor and roof drains and equal to the listed catalog numbers in type, materials and features.

B. Cleanouts located in floors shall be J.R. Smith Series 4020 consisting of two-piece adjustable housing, ABS, cast iron or bronze NPT gasketed plug and round non-slip nickel-bronze cover with securing screw. Additional features such as clamping device for waterproof membrane, synthetic covering top, heavy duty top, carpet flange or carpet marker shall be provided as appropriate for the installation.

C. Cleanouts located in walls and partitions shall be J.R. Smith Series 4472 consisting of cast bronze plug and round stainless steel access cover secured by vandal-proof center screw. Wall cleanouts that cannot be made accessible in this manner shall be provided with an access panel as described in 22 05 04 Basic Plumbing Materials and Methods.

D. Exterior cleanouts in areas not subject to vehicular traffic shall be J.R. Smith Series 4220. Cleanouts shall consist of a cast iron two-piece adjustable housing, ABS, cast iron or bronze NPT gasketed plug and round non-slip cast iron top with securing screw. In area with decorative paving, tops shall be nickel bronze or bronze.
E. Exterior cleanouts in areas subject to vehicular traffic shall be J.R. Smith Series 4250. Cleanouts shall consist of ABS or cast iron gasketed plug, heavy duty double flanged housing and round non-slip cast iron cover with securing screws.

F. Refer to Part 3 for installation and concrete anchorage of exterior cleanout covers at grade.

PART 3 - EXECUTION

3.1 Floor drains shall be set with rim below finish floor level to permit continuous floor pitch to drain, unless otherwise noted or directed. Verify exact location and desired rim elevations before installation.

3.2 Roof drains shall be set as low as practicable in the roof construction to enhance the probability of complete drainage of the roof area served. Drains shall be compatible with the related roof construction. Installation shall be in accordance with architectural details when such details are provided.

3.3 Roof drains shall be installed with bearing pans extending 8 inches out from the clamping ring of the drain. The pan shall be placed on the roof deck below the insulation. Secure the clamping ring and drain top after the roofing membrane has been installed.

3.4 All carriers shall be equipped with feet properly adjusted to rest firmly on the floor. Carrier feet shall be block base type and shall be bolted securely to the floor slab using all bolt holes provided.

3.5 Cleanouts shall be same size as pipe thru 4 inch size. Maximum size of cleanouts shall be 4 inches diameter unless larger units are required for testing or special access purposes. Provide cleanouts where indicated on the drawings and at other locations where deemed advisable. Location of cleanouts as stipulated by applicable code shall be considered as the minimum requirement.

3.6 Exterior cleanout covers, when not installed in concrete or other poured hardscape surfaces, shall be set flush with grade and secured with 1 cu. ft. of concrete formed square, with top surface finished.

END OF SECTION
PART 1 - GENERAL

1.1 Plumbing fixtures installed in place complete with supports, supply and waste trim shall be provided as shown on the drawings and as specified.

1.2 Refer to Division 7 for submittal, qualification, storage, handling warranty and installation requirements for joint sealants. Shop drawings shall be submitted to the Architect / Engineer for review and approval.

1.3 All plumbing fixtures, equipment and trim shall meet the dimensional and performance requirements of the ANSI, ARI, ASME, ASSE and/or CSA standards listed in the current jurisdictional plumbing code.

1.4 All piping, fittings, valves, solders, fluxes, seals, fixtures, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Fixtures and Trim:

A. Refer to schedule on the drawings for fixture specifications, including supply and waste trim and carriers where required. The schedule lists catalog numbers of various manufacturers. These catalog numbers are for the purpose of comparison to establish the construction material, quality and features of the fixtures and their components. Fixtures of equal quality by manufacturers listed in each category will be acceptable.

B. Fixture supply trim shall be of non-ferrous construction and supplies to each fixture shall be individually valved. Valves, supplies and escutcheons shall be furnished with the fixture supply trim.

C. Where exposed to view, all waste trim and supply trim shall be brass chrome plated furnished with wall escutcheons.

D. Screwed nipples serving fixtures from copper tube supply system shall be solid brass to avoid electrolytic corrosion. Exposed nipples shall be chrome plated.

E. Fixtures shall be white unless otherwise noted.

2.2 Joint Sealants

A. Joint sealants shall be by Pecora, Sonneborn, Tremco, or equal by Division 7 listed manufacturers.

B. One part, mildew resistant silicone, ASTM C-920, Type S, Grade NS, Class 25 with fungicide, white, equal to Pecora 898.

PART 3 - EXECUTION

3.1 Installation

A. Space fixtures and rough-in carefully. Fixtures shall be carefully assembled and connected to the required plumbing outlets so the equipment will be ready for use when work is completed. Height shall be within 0.50 inch of specified nominal.
B. Secure supply and waste piping in chases and walls to preclude loose and ill-fitting pipes thru wall. Drop ear ell fittings shall be utilized at all supply nipples and shower arms.

C. After installation of the fixtures is completed, all connecting pipes shall be flushed out through the fixtures to eliminate scale, and all valves shall be properly adjusted and fixtures left complete and ready for use. All fixtures shall be cleaned immediately prior to acceptance by the Owner.

D. Seal joints around each fixture at wall, floor and any adjacent construction.

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May 10, 2019
PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, and Supplementary Conditions, including Divisions 00 and 01, apply to work specified in this Division.

B. The scope of the Division 23 work includes furnishing, installing, testing and warranty of all work and complete HVAC systems as shown on the H-series drawings, and as specified in Division 23 and elsewhere in the project documents.

C. The project drawings and specifications define scope of work for the various divisions. Such assignments of work are not intended to restrict the Construction Manager in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

D. Take special care in reviewing and including required responsibilities as detailed in the Commissioning Specification Section 01 91 13 and 23 08 00. Instruct respective subcontractors to do the same.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the Division 23 work. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Inspect the premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect / Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect / Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having ductwork, pipe and fittings fabricated and delivered in advance of making actual
measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install ductwork, piping and equipment.

D. The Architect / Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be reallocated at the expense of the contractor causing such conflict. The Architect's / Construction Manager's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary drains and minor valves, traps, dampers and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect / Construction Manager. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect / Construction Manager.

1.5 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 23 Contract. Necessary work of this nature will be arranged by the Owner / Construction Manager to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Architect / Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

C. Material provided for work performed under Division 23 shall not contain asbestos.

1.6 Coordination Drawings

A. The Division 23 Contractor shall prepare and be responsible for 0.25inch scale electronic coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format with the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 23 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval, and drawings have been submitted and reviewed by the Engineer.
B. Review by the Engineer is cursory. It is the Contractor's responsibilities to ensure that all work is coordinated, including fit above ceilings, and that specified ceiling heights are maintained.

C. In addition, submit separate “Sheet Metal Only” drawings for review by the Engineer.

1.7 Coordination Drawings
A. Refer to Divisions 00 and 01 for requirements.

1.8 Inspection
A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.9 Record Drawings
A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work, and within 90 days of system acceptance, these drawings shall be turned over to the Architect / Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.10 Operating and Maintenance Manuals
A. Assemble two copies each of operating and maintenance manuals for the HVAC work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

C. Final air and water balance reports and as-built automatic temperature controls drawings and specifications shall also be included.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer and Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

1.11 Final Inspection and Punch List
A. As the time of work completion approaches, survey and inspect Division 23 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected his work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate
explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken to the satisfaction of the Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.12 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Use of equipment for temporary heating or cooling is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.

C. This provision shall not be construed to include maintenance items such as replacing filters, re-tightening or repacking glands, greasing, oiling, belt tightening and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

1.13 Pre-Installation Meetings

A. Refer to Section 01 30 00 Administrative Requirements.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

A. All equipment and appliances shall be listed and labeled in accordance with the Mechanical Code. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance.

2.3 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.4 Equipment Selection
A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will only be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

D. If extensive changes in pipe, duct or equipment layout, electrical or control wiring, or equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract, including other effected trades.

2.5 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here within.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Shop drawings of the following HVAC equipment and materials shall be submitted:

1. Pipe, fittings and joining methods for the various systems.
2. Pipe hangers and saddles.
3. Valves.
4. Flexible connectors.
5. Gauges.
7. Pipe insulation.
8. Equipment and breeching insulation.
9. Ductwork insulation.
11. Furnaces and cooling coils.
12. Rooftop heating and cooling units.
14. Unit heaters.
15. Fans.
16. Roof ventilators.
17. Air filters.
18. Smoke detectors.
19. Air control terminal units.
20. Variable air volume/temperature control system.
21. Air outlets and inlets.
22. Variable Frequency Drives
23. Automatic Temperature Controls.
24. Pressure piping system welder performance qualification record.

PART 3 - EXECUTION

3.1 Pipe Testing

A. All piping provided in this work shall be pressure tested, as specified below, including all connected coils and equipment.

B. Pipe testing for HVAC piping shall be:
   1. Water piping - metallic - hydrostatic at 125 psig or 1.50 times maximum operating pressure throughout the system, whichever is higher for 6 hours at the low point of the system.
   2. Water piping – nonmetallic - hydrostatic at 1.50 times maximum operating pressure throughout the system, for 6 hours at the low point of the system. Prior to testing, verify that test pressure does not exceed pipe manufacturer's test pressure recommendations or rating.
   3. Condensate drainage piping, same as for plumbing drainage piping.
   4. Other piping - refer to appropriate Sections.

C. Testing shall be performed prior to application of insulation. Ensure that air is vented from piping when piping is hydrostatically tested.

D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

3.2 Pipe Cleaning

A. Before placing each water and condensate piping system in operation, the piping system shall be thoroughly flushed out with clean water.

B. Hydronic, condensate and other closed circuit water system piping and connected equipment shall be further cleaned by introducing a low foaming detergent solution and circulating the solution throughout the system for a 2-hour period. However, equipment that is subject to fouling from the flushing process shall be isolated when recommended by the equipment
manufacturer. This may include boilers, plate and frame type heat exchangers, and small coils. Follow equipment manufacturers' cleaning and flushing instructions. Clean strainers at the end of this period. Pump suction diffuser start-up strainers shall be removed after initial circulation and cleaning of the system. The system shall be thoroughly flushed with clean water before refilling.

C. Refer to appropriate Sections for cleaning of other piping for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each piping system and air distribution system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing air and water systems, adjusting fan speeds, belts, pulleys, tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

C. Test relief valves, air vents and regulating valves to ensure proper operation.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

3.5 Spare Filters

A. Furnish one complete initial set of filters and one complete set of spare filters for each filter bank in the project. This is in addition to filters used for temporary heating.

END OF SECTION
PART 1 - GENERAL

1.1 The Engineer, at his sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer’s Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form. Charges are for the Engineer’s time to prepare the documents in the format stated. They are available through the Engineer’s office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor’s systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project’s name and address, the Architect’s / and / Engineer’s / and / any consultant’s name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor’s risk, and shall in no way alter the contractor’s Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer’s or its consultant’s computer software or hardware defects or errors; the Engineer’s or its consultant’s electronic or disk transmittal of data, information or documents; or the Engineer’s or its
consultant’s reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer’s consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney’s fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor’s distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached “Agreement” shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION
Project: Kettering City Schools  
Southdale and Orchard Park Elementary  
Dayton, Ohio

Owner: Kettering City Schools

Heapy Engineering Project Number: 2019-07023

Heapy Engineering Project Manager: David Madden

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files.

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:
   
a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

   b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

   c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.
d. That the Recipient agrees that its use of the Electronic Files is at the Recipient’s sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient’s receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

   a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

   a. Are suitable for any other usage or purpose.

   b. Have any particular durability.

   c. Will not damage or impair the Recipient’s computer or software.

   d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney’s fees, arising from or by reason of the Recipient’s use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications.
The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient’s conversion or electronic file storage at the Recipient’s requested site, shall be at Recipient’s sole risk.

13. Recipient acknowledges:

   a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

   b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose.

   c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

   d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant’s consent may be assigned or transferred by Recipient to any other person or entity.

Provider (Name of Company): 

Recipient (Name of Company): 

Recipient Address: 

Name of authorized Recipient Representative: 

Title of authorized Recipient Representative: 

E-mail address of authorized Recipient Representative: 

Signature of authorized Recipient Representative: 

Date: 
NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: ________________________________

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ CD-ROM  ☐ DVD-ROM  ☐ Heapy FTP  ☐ User’s FTP site ☐ Flash Drive

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 20XX DWG

If a different file version is required than the indicated available version state the requested version:

______ .DWG

Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 23 Electronic .DWG Files:

First Drawing: $50.00

Additional Drawings $15.00 each _______ x $15.00 = $_______

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _______ x $ 5.00 = $_______

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $_______

All files will be bound together.

Available electronic Revit file format:
☐ 20XX .RVT

Cost of Preparation of Division 23 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $_______
PART 1 - GENERAL

1.1 Temporary Heating and Cooling

A. The temporary heating and cooling for construction is provided by the Contractor. Refer to Division 01 - General Requirements.

B. Fuel and electric costs attendant to temporary heating and cooling are not included in Division 23.

C. The use of the permanent HVAC systems for temporary heating and cooling during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period. Provide and maintain temporary air filters (same as specified permanent filters) to protect coils and ducts. Replace temporary filters with the clean specified filters when the systems are turned over to the Owner. Air filters specified for the systems and units, including specified spare filters, are not to be used for temporary service.

D. Cover all return duct openings with temporary MERV 8 filter media. Stop fans during heavy dust generating operations. Before turning the system over to the Owner, clean duct interiors and interior surfaces and components of the air handling equipment.

E. Warranty periods on equipment, materials and system shall commence upon Owner acceptance of the building or systems. Temporary heating or cooling use shall not jeopardize or alter the warranty requirements.

F. The use of the permanent HVAC systems for temporary heating and cooling shall not be allowed. Provide portable spot heaters and coolers to maintain interior conditions as defined by the General Contractor / Construction Manager. Coordinate power requirements with the electrician. Provide temporary drains and ducts as needed.

Cover all supply and return openings. When air balancing the permanent systems, all dust producing operations need to have ceased. Clean any ductwork or equipment that becomes dusty or dirty.

1.2 Continuity of Services

A. Work shall be so planned and executed as to provide reasonably continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner and Construction Manager shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

PART 2 - PRODUCTS

2.1 Access Panels
A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devices and equipment requiring service or adjustment.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with screwdriver lock / tamperproof screws / industrial grade lock set. Locks in “secured” areas of the building shall have tamperproof screws / be institutional grade locksets. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.
2. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls, Milcor Style “ATR” or equal.
3. Standard flush type for drywall walls, Milcor Style “M” or equal.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18 inches x 18 inches unless larger panels are shown or required. Panels shall be equal to Chicago Metallic Model CRG.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect or Construction Manager.

B. The Owner’s property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching New Buildings

A. Refer to Division 01 - General Requirements and Special Conditions for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes and ducts are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this
work, or pay other trades for doing this work when so directed by the Architect or Construction Manager. Any damage caused to the building in this work shall be repaired or rectified.

C. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

3.4 Cutting and Patching Projects with Remodeling

A. Refer to Division 01 - General Requirements and Special Conditions for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes and ducts are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Trades to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect or Construction Manager. Any damage caused to the building shall be repaired or rectified.

C. Where pipes and ducts are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching and refinishing of same shall be included in this contract. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls, etc. are to be cut for presence of existing utilities.

D. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system brace floor or alter location of new work to maintain existing system.

E. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

F. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

G. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

H. Engage a Roofing Contractor on a subcontract basis for roofing and roof insulation work necessitated by the HVAC work. The Roofing Sub-Contractor shall be certified for installation and repair of the Company Name and Roofing Type roofing system so as to maintain the existing roofing warranty.

3.5 Removals, Alterations and Reuse Projects With Remodeling

A. Refer to the drawings for the scope of remodeling in the existing building.

B. Cooperate with all trades and Construction Manager regarding all removal and remodeling work. Unless otherwise noted, remove existing work which is associated with Division 23 and which will be superfluous when the new work is installed and made operational.

C. Extraneous ductwork and piping which is or becomes accessible shall be removed and stubs shall be capped at the first active duct or pipe encountered. Ductwork and piping that is and remains inaccessible shall be abandoned. Ends of abandoned duct and pipe shall be capped.
so as to be concealed by finished surfaces. Upon completion of the work no abandoned duct, pipe, valve or stub shall extend thru finished floors, walls or ceilings.

D. When it is necessary to reroute a section of active ductwork or piping the rerouted section shall be installed before removing the existing in order to minimize system down time. Rerouted sections shall be insulated as required for new work. Patch insulation on existing ductwork and piping which has been damaged or removed in this work.

E. Materials and equipment which are removed shall not be reused within the scope of this project unless specifically noted to be relocated or reused. Turn over to the Owner and place where directed on the premises all removed material and equipment so designated by the Owner. All material and equipment not claimed by the Owner shall become the property of the Contractor responsible for removal and shall be removed from the premises.

F. Remove, store and reinstall lay-in ceiling tile and grid as needed to perform work in areas where such removal and re-installation is not to be done by others. Damaged tile and/or grid shall be replaced with new matching tile and/or grid.

G. In areas of minor work where the space is not completely vacated, temporarily move portable equipment and furnishings within the space as required to complete the work. Coordinate this activity with Owner / Construction Manager. Protect the Owner's property by providing dust covers and temporary plastic film barriers to contain dust. Remove barriers and return equipment and furniture upon completion of the work.

H. Refinish any surface disturbed under this work to match existing, except where refinishing of that surface is included under the General Contract.

3.6 Painting

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite / 221 cold galvanizing compound or approved equal, for touch-up of previously galvanized surfaces.
5. Inside of ducts, behind grilles and registers, shall be painted flat black to eliminate the viewing of shiny surfaces.

B. Paint, surface preparation and application shall conform to industry standards / applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.

C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.7 Access Panels
A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall/ceiling.

3.8 Miscellaneous Equipment Connections

A. Make all final connections to these fixtures and equipment, as indicated and in accordance with the manufacturer’s recommendations. All piping connections shall be valved and final connections made with unions.

B. Hydronic connections to equipment shall be in accordance with manufacturers installation guidelines. Provide at each supply connection, at a minimum, a shut-off valve, strainer, pressure and temperature gauges, P/T test plug and a union. On each return connection provide a union, pressure and temperature gauges, P/T test plug and a shut-off valve. Also provide any additional accessories recommended by the equipment manufacturer.

C. Roughing-in drawings shall be obtained for the various fixtures and items of equipment as the time approaches when such information is required; allow a reasonable period, from the time of notice, to obtain this information.

3.9 Miscellaneous Component Installations

A. Certain miscellaneous items and components are furnished loose and require installation into the duct systems, piping systems, and other HVAC systems. These items shall be installed per the suppliers and manufacturer’s instructions.

B. This shall include, but by no means be limited to, items such as balancing dampers, backdraft dampers, motorized dampers, gravity dampers, fire and/or smoke dampers, sound attenuation products, control valves and components and other similar items.

C. Provide compatible connection means for all items being installed.

D. Provide bulb wells for temperature control equipment, and coordinate accordingly. Other types of control devices (dp switches, flow switches, flow meters, etc.) shall also be installed, with devices, needed fittings (tees, weldolets, threadolets, etc.), locations and installation details closely coordinated.

E. Provide all required access means (access doors, etc...) required for installation, service and inspection.

END OF SECTION
PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping and non-fire dampered ducts thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and HVAC drawings for pipe and duct layouts.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the code and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer’s engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer’s specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions. Submittals shall include all information required in OBC Chapter 1, Section 106 and Chapter 7, Section 712.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Rectorseal-Metacaulk, Tremco, Nelson, Specified Technologies or other approved manufacturer.

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer’s instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Firestopping shall not be installed at fire dampers that would impair the needed free expansion of damper, sleeve and retaining angles in a fire condition. Refer to the installation instructions of the fire damper manufacturer.

3.4 Refer to 23 05 07 Piping Materials and Methods for pipe sleeve requirements and treatment of penetrations not requiring firestopping. Refer to 23 31 13 HVAC Ductwork for duct sleeve requirements where firestopping is required.

END OF SECTION
PART 1 - GENERAL

1.1 Piping materials and methods shall be as specified herein and as shown on the drawings.

1.2 Included in this section are:
   A. Pipe, fittings and joining methods.
   B. Unions and flanges.
   C. Dielectric connectors.
   D. Pipe sleeves, openings, curbing and escutcheons.
   E. Installation methods of piping.

1.3 Refer to other Sections in Division 23 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.4 Refer to Section 23 05 05 Firestopping and Division 7 for firestopping requirements.

1.5 Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications. Submit welder certifications for record.

1.6 Welding procedures and testing shall comply with ANSI Standard B31.1.0 - Standard Code for Pressure Piping, Power Piping and The American Welding Society Welding Handbook.

1.7 Piping between the power boiler (steam boiler above 15 psig) and the valve or valves required in ASME Code, Section I, shall be in conformance with ANSI B31.1 - Power Piping. Welding shall be performed under PP (Pressure Piping) certification and so stamped. Submit welder certifications for record.

1.8 Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe.

1.9 Sleeves are not required:
   A. For insulated piping passing thru stud and gypsum board or plaster walls and partitions which are not fire rated.
   B. For uninsulated piping passing thru stud and gypsum board or plaster walls and partitions which are not fire rated.
   C. In large floor openings for multiple pipe and duct risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after pipes are set.

1.10 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS
2.1 Copper tubing, conforming to ASTM B88, Standard Specification for Seamless Copper Water Tube and Fittings and Joints, shall be:

A. Type C1
   Pipe - Type "L" seamless hard drawn copper tubing.
   Fittings - wrought copper or cast bronze, solder ends, ASTM B16.
   Joints - soldered with lead-free tin alloy, 95-5 tin-antimony or silver-bearing tin equal to Harris "Stay-Brite", "Stay-Brite 8" or "Bridgit".

B. Type C2
   Pipe - Type "L" seamless hard drawn copper tubing.
   Fittings - wrought copper or cast bronze, solder ends, ASTM B16.
   Joints - brazed with 15 percent silver brazing alloy equal to Harris "Stay-Silv 15" or Harris "Dynaflow".

C. Mechanically formed tee fittings and couplings in copper tubing may be provided in lieu of standard tees and couplings. Mechanically formed tees and couplings shall be T-Drill or approved equal. This method is not permitted, however, in refrigerant piping systems.

2.2 Unions and flanges shall be:

A. Unions on copper tubing, all bronze construction 150 lb., solder ends.

B. Unions on steel pipe 2 inches and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

C. Flanges on steel pipe with welded or screwed joints, 2.50 inches and larger. Gaskets shall be 0.0625 inches thickness full face compressed sheet suitable for temperature and pressure ranges of the application.

D. Mechanical joints associated with grooved end pipe are acceptable in lieu of unions and flanges.

E. Unions on plastic pipe, same composition and pressure rating as the piping system.

2.3 Dielectric connectors are required at each connection between ferrous and non-ferrous piping. Insulating materials shall be suitable for system fluid, pressure and temperature. Connectors shall be one or more of the following:

A. Brass adaptor.

B. Dielectric couplings (may only be used on water systems operating at less than 100° F.):
   Dielectric coupling with non-conductive polymer liner, threaded ends; and 300 psig minimum working pressure at 225 degrees F. continuous service. Victaulic Clearflow Waterway Style 47, Gruvlock “Di-Lok”, or Lochinvar Corp. “V-Line”.

   A shut-off valve shall be provided locally on the system side of the coupling, so that repairs can be made without shutting down the entire system.

C. Dielectric Waterway (may only be used on water systems operating at less than 100° F.):
   Fittings shall be a copper-silicon casting conforming to UNS C87850, and UL classified in accordance with ANSI / NSF-61 for potable water service. Fittings shall have threaded ends, grooved ends, or a combination. Victaulic Style 647.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum working pressure as required to suit system pressures, and suitable for 225 degrees F. or higher.
1. Acceptable Manufacturers:
   a. Capitol Manufacturing Co.
   b. Epco Sales, Inc.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly, include flanges, full-face or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers, all suitable for 225 degrees F continuous service or higher.

1. Acceptable Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150 or 300 psig minimum working pressure where required to suit system pressures.

2.4 Pipe sleeves shall be:

A. Schedule 40 black steel pipe or 18 gauge galvanized steel in poured concrete floors, walls and roof decks.

B. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

C. Combination pre-set floor sleeve and firestopping assembly equal to Hilti CP 680. Refer to 23 05 05 Firestopping.

2.5 Concrete curbs may be formed and poured around multiple pipe risers in rooms with waterproofing floor membrane, in lieu of the Smith 1720 riser sleeve and clamping ring. Curbs shall be 4 inches wide x 4 inches high with chamfered corners. Membrane and curbing shall be arranged to maintain the integrity of the membrane. Pipe sleeves shall be as described for normal areas or extended to the top level of the curb where the concrete is full depth throughout the curbed area.

2.6 Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Piping shall be pitched for drainage. The low points shall be fitted with a 0.75 inches drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1.25 inches and smaller where a drain valve is not shown, a drain plug is acceptable. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.

3.3 Piping shall be installed consistent with good piping practice and run concealed wherever possible. Coordinate with other trades to attain a workmanlike installation.

3.4 Piping shall be supported as specified in Section 23 05 29 Hangers and Supports for HVAC Piping. HDPE piping / Piping with mechanical joints for grooved end steel pipe shall be supported in accordance with the manufacturer's recommendations, including expansion compensation. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.
3.5 Press connections: Copper press fittings shall be made in accordance with the manufacturers installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing if fully engaged (inserted) in the fitting. The joints shall be made using a calibrated tool approved by the manufacturer.

3.6 Grooved joint couplings and fittings shall be installed in accordance with the manufacturer’s written installation instructions, including proper lubricant and torquing. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer’s representative shall periodically visit the jobsite and review installation, and the Contractor shall remove and replace any joints deemed improperly installed.

The manufacturer’s representative shall also provide at least three progress reports back to Project Team, two during the construction phase and one as the project is completed. These reports (for information purposes only), shall include pictures demonstrating installation methods, 10% sampling of torqued fittings (to show with-in acceptable range), and shall serve solely as progress reports for the Project Team.

3.7 Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering. Where silver brazing is specified, solder connection of valves shall be used to reduce the danger of damage.

3.8 Piping within 2 ft. of the coil connections to small heating and/or cooling units, reheat box coils and duct coils may be Type "K" soft copper to facilitate connection in a confined space. Joints shall be brazed or soldered consistent with the piping system or flared-tubing fittings may be used where appropriate.

3.9 Close open ends of piping during installation to keep interior of the pipe clean.

3.10 Pump suction diffuser start-up strainers shall be removed after initial circulation and cleaning of the system.

3.11 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the National Electric Code (NEC).

3.12 Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection purposes. A union shall be installed at each threaded shut-off valve on the side of the valve for which shut-off service is intended.

3.13 Pipe sleeves shall be placed, and structural footing relieving arch requirements shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the project Structural Engineer.

3.14 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water, refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well. Refer to the following paragraph for qualifications and exceptions relating to firestopping.
3.15 Refer to 23 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.16 In lieu of firestopping and where permitted by the OBC, uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar).

3.17 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with caulking to retard the passage of smoke.

3.18 Dielectric connectors shall be provided at all locations described herein, at each connection between ferrous and non-ferrous piping, and as shown on the drawings. A shutoff valve shall be provided locally, on the system side of all dielectric couplings, so that repairs can be made easily on these fittings without shutting down the entire system.

Cooling condensate drain piping shall be installed per details and equipment manufacturer’s instructions. Horizontal runs shall be pitched to drain, constructed with DWV fittings, and provided with a clean-out every 50 LF of piping unless shown more frequently on the plans.

END OF SECTION
PART 1 - GENERAL

1.1 Motors, starters, disconnects, devices, fuses, wiring and other electrical work included in Division 23 shall be factory installed or furnished and field installed as specified in the various specification sections and as shown on the drawings. Refer to the project documents for requirements related to each trade. Coordinate all aspects of electrical components and wiring to complete the systems.

1.2 Equipment control panels containing power control components shall be marked with the minimum SCCR rating. The rating shall not be less than the available fault current. Refer to the electrical drawings for the calculated available fault at the distribution panel, MCC or panelboard serving the equipment. Include confirmation of being protected from the fault current in the equipment shop drawing submittal.

1.3 Note: Equipment with Electronically Commutated Motors (ECM’s) are sometimes factory programmed to limit current draw to the motor, to limit the available brake horsepower to better match specified performance and reduce required power circuiting. This reduced brake horsepower is likely below the motor’s nameplate rating. The electrical design documents may be sized based on the ECM’s nameplate motor horsepower. The equipment supplier shall notify the Division 23 and 26 contractors and the Engineer if the maximum overcurrent protection on the design documents differs from their selected equipment’s nameplate data. Any required revisions to the electrical circuiting, including maximum over-current protection devices, shall be documented on the shop drawing submittal. The required revisions must be forwarded to the Division 26 contractor with enough time to adjust the over-current protection and the electric circuit installation. However, any additional cost associated with increased electrical feeder/breaker sizes or lack of coordination listed above shall be the Division 23 contractor’s responsibility.

1.4 Refer to the Electrical drawings and verify adequacy of feeder size, sets of conductors and size, disconnecting means and other electrical requirements. Compare these to the requirements of the equipment to be furnished and report deficiencies and / or discrepancies to the Engineer in the bid period for resolution by addendum. Bear all costs for electrical changes where such issues are not properly resolved.

1.5 Equipment and devices shall comply with applicable standards of NEMA and shall be UL listed. All work shall comply with the National Electrical Code.

1.6 Electrical equipment, devices, fuses, wire, conduit and methods shall comply with applicable provisions of Division 26 - Electrical.

PART 2 - PRODUCTS

2.1 Motors

A. General purpose motors shall be induction type 1750 rpm NEMA Design "B" with copper windings, Class B or F insulation, and motor enclosure to suit the application. Service factor shall be 1.15 minimum.

B. Two-speed motors shall be two-winding type with six leads unless otherwise specified.

C. Motors for other than general duty application shall be furnished to suit the application and operating environment.

E. Motors used with Adjustable Frequency Motor Controllers (Variable Frequency Drives) shall be rated for inverter service in accordance with NEMA Standard Publication MG-1, Part 31 and designed with Class F or H insulation, but with a Class B temperature rise. Motors connected to VFD’s shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer.

F. Motor sizes shown on the drawings are to be considered minimum. Motors furnished shall be sized so as to not operate in the service factor range. Motors for direct driven pumps and fans shall be selected so as to not operate in the service factor range at any point on the curve.

G. Compare the electrical power requirements of the intended equipment with power feeders to the equipment shown on the Electrical drawings. Verify adequacy and compatibility of voltage, phase, wiring capacity, number and size of conductors (versus equipment connection points), maximum over-current protection, fusing and other information to that required for the equipment. If the selected equipment requires revision of the electrical, include any added cost to do so.

2.2 Magnetic starters shall comply with provisions of Division 26 - Electrical specifications and shall be NEMA construction (IEC rated not acceptable) with thermal overload element on each phase, 115 volt control voltage and hand-off-automatic switch, where appropriate. An integral control transformer shall be incorporated in the starter for each motor of 200 volt and greater. A single control transformer is acceptable for multiple motor packaged equipment, however, when such is the manufacturer's standard. Duplex type units (pumps, compressors, etc.) are not included in this exception. A control transformer shall be provided in each starter to ensure standby operating capability.

2.3 Wire and conduit shall comply with applicable provisions of Division 26 - Electrical specifications. Control wiring lighter than No. 12 AWG is acceptable where lesser ampacity will permit. All power and control wiring shall be overcurrent protected per the National Electric Code.

PART 3 - EXECUTION

3.1 Motor connections of factory assembled equipment shall be made with flexible conduit except for plug-in electric cord connections.

3.2 All power wiring shall be run in conduit. Control wiring shall be run in conduit except where open wiring is specified in the various sections.

3.3 Fuses shall be furnished and installed in fuse clips of equipment and switches.

END OF SECTION
PART 1 - GENERAL

1.1 Provide a single enclosure adjustable frequency speed control package for induction motors where shown on the drawings and included in the Specifications with input power at the voltage and phase as scheduled on the drawings. The output power rating of the controller shall not be less than the full load rating of the motor, plus 5 percent. Controller shall be the latest design solid-state device, listed by UL, CSA or etc.

1.2 The adjustable frequency controller is to be PWM (pulse-width-modulated) design for motor voltage, current and frequency control. Impact three-phase AC line voltage is rectified to DC voltage for full conversion to near sensor output.

1.3 The supplier of the drives shall have factory trained service personnel on staff and shall submit documentation showing so with the shop drawings. Lack of documentation will result in unapproved shop drawings. The supplier shall also provide a 5-year parts and labor warranty, and a 5-year service contract for the supplied drives.

1.4 The drive shall have the same control logic board for all horsepower ratings. The 32-bit microprocessor will deliver the computing power necessary for complete three phase motor control.

1.5 The drive MTBF (Mean Time Between Failures) shall not be less than 20 years.

1.6 The term “Variable Frequency Drive”, “VFD”, “Variable Speed Drive” and other similar terms as used in Division 23 and on the drawings shall refer to Adjustable Frequency Motor Controller.

1.7 Motors connected to VFD’s shall comply with 23 05 13 Electrical Requirements for HVAC Equipment and shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer.

1.8 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Manufacturers and Suppliers

A. Adjustable frequency motor controllers shall be manufactured by Yaskawa by Stoermer Anderson, Square D by Spears Mechanical, ABB, Franklin Control Systems, Allen Bradley (1336 plus II), Mitsubishi, or Eaton.

B. Suppliers of adjustable frequency motor controllers must be an authorized service agent of the controller. Proof of this shall be provided with shop drawing submittals.

C. When adjustable frequency motor controllers are specified to be included in a factory-installed packaged system specified elsewhere in these specifications, the manufacturer of the controller is not limited to the acceptable manufacturers listed above. However, the supplier of the packaged system shall be an authorized service agent for the adjustable frequency motor controller being provided.

2.2 The controller shall be capable of varying its output in response to a remote 0 10 VDC or 4 20 mA signal, proportional to drive monitor functions. Provide controls mounted in face of the enclosure for the following functions:
A. Digital operator keypad and display, with copy function, provides local control and readout capability: Hand/Off/Auto, Speed Reference, and Reset commands.

B. Power On, Run on Drive, Run on Bypass (when bypass is specified), and Fault LED Pilot Lights.

C. Door mounted (face of cover) diagnostic indicator with touchpad interface shall incorporate:
   1. Controller Run
   2. Voltage to Motor
   3. Current to Motor
   4. Speed Indication in Hertz, Percent, RPM
   5. KW
   6. Elapsed Time Meter
   7. Overtemperature
   8. Overcurrent
   9. Overfrequency
   10. Overvoltage
   11. Undervoltage
   12. Motor Overload
   13. Ground Fault
   14. Short Circuit
   15. Phase Loss
   16. Control Circuit Fault

D. "Manual/Auto" speed control selector switch and manual speed adjustment with switches and indication on face of cover. Switch shall select control of motor speed from either the ATC system or the manual speed adjustment.

2.3 The controller shall include the following inputs and output functions at a labeled terminal strip. All inputs and outputs must be completely isolated from the analog reference signal:

Inputs

1. Remote/Local operation selection
2. Detection of external overheat condition
3. Preset speed selection
4. Serial communication selection
5. PI control disable
6. Run/Stop control
7. Fault reset
9. Speed Control Signal
10. External Trip Contact NO/NC
11. Freezestat Trip
12. Smoke Detector Trip

Outputs

1. Two (2) programmable multiple function output relays providing any two (2) of the following: zero speed detection, low and high frequency detection, missing frequency reference, overtorque/undertorque detection, serial communication status, or no load detection (broken belt alert).
2. Trip “Fault” (Form C Contact)
3. Output Frequency (0-10VDC)
4. Choice of Output Current, Voltage and Frequency

2.4 Speed control shall be linear from 10 to 100 percent of full speed. Both the minimum and maximum speed limits shall be adjustable. The controller output frequency shall not change as a result of up
to a 10 percent input voltage fluctuation. The acceleration and deceleration rates shall be fully adjustable. Provide current limit function to avoid excessive automatic acceleration and deceleration when an overcurrent condition exists. The volts to hertz ratio shall be adjustable. Critical frequency rejection points shall be provided and shall be programmable, minimum of 3; deadband available.

2.5 The speed control output transistors are to be Insulated Gate Bipolar Transistor (IGBT) type for PWM design to facilitate a switching frequency of up to 12 kHz to eliminate the audible noise associated with PWM designs. The audible noise emitted from the motor must be within 5 db of the noise during across-the-line operations at all frequencies within the human audible spectrum (up to 12 kHz operating frequency). The drive must be selected for operation at or above 5 kHz without derating to satisfy the conditions for current, voltage or horsepower as shown on the drawings.

2.6 The controller shall permit disconnection of power from the input or output line voltage with the controller running under load without damage to the controller components. The controller shall be able to withstand an output line short (phase to phase or phase to ground) without damage to the controller components. Controller shall shut down on short circuit and detection of any of the following conditions: current 110 percent above rated current for 60 seconds; phase loss; input overvoltage and undervoltage; high internal temperature; ground fault and under frequency. Short circuit current rating (SCCR) shall not be less than 65,000 amps RMS, 100,000 amps RMS with link choke.

2.7 The controller shall have an automatic restart function to attempt restart after the unit trips off when power is lost to the unit. A time delay shall be provided between restarts. The unit shall not attempt to restart more than five times in the automatic mode. In addition, the controller shall have a power loss ride feature of at least 2 seconds (120 cycles) to prevent unnecessary trip out due to momentary input power interruptions.

2.8 The drive system (motor and controller) shall provide a minimum power factor of .95 at power input throughout the speed range, and a minimum efficiency (output to input line) of .82 at 100 percent speed and .70 at 50 percent speed.

2.9 The controller and any associated hardware shall be load tested at the controller manufacturer's plant prior to shipment.

2.10 The controller shall not create any feedback noise on the input line that will adversely affect electronic or microprocessor based equipment (such as computers or electron microscopes), and the controller shall not impress voltage or current spikes on the system. The minimum requirements shall conform to IEEE Standard 519, Special Applications for Line Notching and Distortion maximum 5 percent THVD at the point of connection to other building loads. The manufacturer shall provide at no additional cost any equipment to meet this requirement; i.e., A.C. line filters of the RLC type and/or isolation transformer, or both as required to meet full compliance with IEEE 519, if controller does not meet all standards.

2.11 Provide a 3 percent or 5 percent AC line reactor on all equipment that does not comply with the THVD requirements stated above.

2.12 Provide 5 percent output reactor and dv/dt filter where motor lead length is greater than 50 feet. Also provide terminations suitable for shielded output power cables.

2.13 The controller shall meet the requirements for Radio Frequency Interference (RFI) above 7 MHz per FCC regulations, Part 15, Subpart J for Class A devices.

2.14 The following additional functional features shall be provided for the controller:

A. Each controller shall be provided with a door interlocked disconnect means and semi-conductor rated fuses.
B. Input line circuit breaker – a main power circuit breaker shall be provided for input power. Door shall be interlocked and through-the-door breaker operating mechanism included. The breaker shall be able to be padlocked with the door open or closed. Breaker to be rated for short circuit current available.

C. Output Overload Relay - Provide an overload relay for motor protection with manual reset pushbutton, all inside the enclosure. Provide the proper size overload elements to match motor nameplate ratings before allowing the motors to be put into service. Provide overload for each motor where multiple motors are served by one controller.

D. Serial Communications – The controller shall provide serial communication to the building automation system via one of the following protocols as coordinated with the BAS: LONWorks, BACnet, Modbus, Ethernet. The following data shall be shared between the drive and the BAS:

Analog Inputs – Speed Reference, Output Speed, Output Cement, KWH Meter, Output Power, Drive Temperature, PI Feedback, AC Output Voltage, DC Bus Voltage, Fault Code, Elapsed Time-Hours, Megawatt Horn Meter, Drive Rated Current, Communication Error Code, PI Deviation, PI Output Capacity, PI Reference, Last Fault Code, Frequency Reference @ Fault, Output Frequency @ Fault, Current and Voltage @ Fault, Operation Status @ Fault, Elapsed Operation Time @ Fault.


Provide all software and hardware necessary to complete the interface to the BAS. Provide the temperature controls installer with all necessary electronic files including XIF and object files. Provide on-site assistance to the temperature controls installer for programming, checkout, start-up and commissioning.

E. NEMA 3R Enclosure – Controllers located outdoors or exposed to an unconditioned environment shall be provided in a ventilated and heated enclosure intended for outdoor use that will allow for operation down to -15 degF.

PART 3 - EXECUTION

3.1 Provide complete wiring diagrams for use in interfacing the ATC equipment. Also submit these diagrams with the shop drawings.

3.2 Wiring shall be in strict accordance with the manufacturer's recommendations. Provide the controller, all control and interlock wiring, and all set-up and commissioning. Coordinate power wiring requirements.

3.3 Each controller shall be mounted to a Unistrut frame where indicated on drawings. Provide 8 inches square by 0.375 inch painted steel base plate at floor below each vertical Unistrut channel to distribute weight on floor. Floor set controller shall be set on 4 inches high concrete base. Small units may be direct mounted to the air-handling unit casing when the AHU manufacturer approves such installation.

3.4 Controller shall be wall mounted / unit mounted / mounted on unistrut framing system.
3.5 Refer to "Identification" Paragraph for nameplate requirements.

3.6 Check full load ampere and service factor rating for each motor after installed and furnish the proper size overload heater elements to protect the motor.

3.7 Each controller shall be started up under the supervision of the manufacturer's representative. Start-up services shall consist of an initial start-up programming and check out of the drive for proper operation. After initial startup the representative shall meet with and work with the Contractor as part of commissioning the Automatic Temperature Control system, providing additional programming and control interface as directed. In addition to start up services, the manufacturer's representative shall provide a minimum of two (2), four hour training classes at the job site for Owner operation, maintenance and servicing.

END OF SECTION
PART 1 - GENERAL

1.1 Refer to Section 23 21 13 Hydronic Piping for selection of valves for the various services. Valves peculiar to individual systems are referenced or specified in Sections related to those systems.

1.2 Valves and materials shall comply with applicable standards and specification of ANSI, ASTM, ASME and MSS. Working pressure and temperature ratings of each valve shall exceed those imposed by the service in which it is applied. Valves shall be manufactured in the U.S.A.

B. MSS SP-70-90 Cast Iron Gate Valves, Flanged or Threaded Ends.
C. MSS SP-80-87 Bronze Gate, Globe and Check Valves.
E. ANSI B16.34, MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.
F. Valves for potable-water service shall have materials compliant to NSF 61.
G. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

PART 2 - PRODUCTS

2.1 Ball Valves - Nibco, Bray, Crane, Apollo, Pro-Hydronic Specialties, Milwaukee, Watts, Kitz, Victaulic, Tyco-Grinnell, Anvil-Gruvlok

A. Type B1. 2 inches and smaller. 2 piece, non-repairable Nibco T 580-70 and T-585-70, 150 w.s.p., two piece bronze body, screwed ends, chrome plated brass ball and silicone bronze stem, PTFE seat and seal, handle.
B. Type B2. 2 inches and smaller. 3 piece, repairable Nibco T 595-Y-66, 150 w.s.p., three piece bronze body, screwed ends, stainless steel ball and stem, full port, PTFE seat and seal, handle.

2.2 Check Valves – Nibco, Crane, Milwaukee, Apollo, Watts, Kitz, Powell, Victaulic, Tyco-Grinnell, Anvil-Gruvlok

A. Type C1. 2 inches and smaller. Swing check Nibco T 413-Y, 125 w.s.p., bronze body, screwed ends, renewable bronze swing disc with PTFE seat ring.
B. Type C3. 2 inches and smaller. In-line spring Nibco T 480-Y, 125 w.s.p., in line spring actuated center guided silent check, bronze body, screwed ends, PTFE disc and seat ring.
C. Type C5. 2 inches and smaller. 200 w.s.p. swing Nibco T 473 B, 200 w.s.p., Y pattern, bronze body, screwed ends, renewable bronze swing disc and seat.

2.3 Gate Valves - Nibco, Crane, Milwaukee, Watts, Apollo, Kitz, Powell
A. Type D1.  2 inches and smaller.
   Nibco T 134, 150 w.s.p., all bronze, screwed ends, solid wedge, rising stem, union bonnet.

B. Type D3.  2 inches and smaller.
   Nibco T 174 SS, 300 w.s.p., bronze body, screwed ends, stainless steel seats, solid wedge, rising stem, union bonnet.

C. Type D5.  2 inches and smaller.
   Nibco T-174-A, 300 w.s.p., all bronze, screwed ends, rising stem, union bonnet.

2.4 Balancing Shutoff Valves - manufacturers as stated:

A. Type E1.  Globe
   Armstrong CBV Series, Tour & Anderson TBV and STA Series, Nibco T1810 for 0.5 inch – 2 inches and F737A for 2.5 inches – 12 inches, Anvil CSV-9520 Series 0.5” thru 1” and MBV-9510 Series for 1.25” and larger, MEPCO “MBV” Series, Victaulic Series 786 / 787 and 788 / 789, Nibco grooved series G737A / Danfoss MSV or, in sizes 4 inches and larger, Bell & Gossett Model CB Circuit Setter.  Globe type, DZR brass or bronze body, positive shutoff design, 125 psi construction, with adjustment shutoff handwheel, memory stop, drain fitting with hose thread end and cap and pressure temperature gauge ports with brass caps and security bands.

   Note that an independent shut-off valve is required at each balancing valve (balancing valve shall not act as the shut-off valve).

   Note that grooved connections are only allowed if grooved piping systems have been specified for associated systems in 23 21 13.

B. Type E2.  Venturi
   Flow Design, Griswold, Pro-Hyronic Specialties, NuTech, or Anvil MBV-9510 Series or Taco Accu-Flo Series.  Ball or Globe valve for sizes 2” and smaller, Globe or Butterfly valve for sizes 2.5” and larger, positive shutoff design, with adjustment-shutoff handle, memory stop, integral venturi flow measurement section and pressure temperature gauge ports with brass caps and security bands.

   Note that an independent shut-off valve is required at each balancing valve (balancing valve shall not act as the shut-off valve).

   Note that grooved connections are only allowed if grooved piping systems have been specified for associated systems in 23 21 13.

C. Type E3 – 2” and smaller only.
   Ball
   Bell & Gossett Circuit Setter Plus or Watts CSM Series.  Ball valve, positive shutoff design, 200 psi, with adjustment shutoff knob, calibrated scale, memory stop set screw and pressure-temperature gauge ports with brass caps and security bands.

   Note that an independent shut-off valve is required at each balancing valve (balancing valve shall not act as the shut-off valve).

D. A portable differential pressure gauge with cocks, hoses and connectors shall be provided in conjunction with the combination balancing valves and flow controllers. Furnish additional gauges as appropriate if one gauge cannot facilitate the various valves.

E. A molded polyurethane container shall be provided with each valve on cold services, to be utilized as an insulating cover.

2.5 Automatic Flow Controllers
A. Type F1.

1. Flow controllers shall be automatic pressure compensating flow control valves factory manufactured for the stated flow rates. Valves shall be selected by the supplier, utilizing the minimum required spring rate or diaphragm range for the system pressure (1-14 psig, 2-32 psig, 4-57 psig, or other as required) and per the drawings, details and schedules. The flow controller body shall be forged or cast brass with ISO-9001 certificate of registration, bronze, or ductile or gray iron. For spring-cartridge type units, spring shall be stainless steel and the cartridge shall be stainless steel or chrome plated brass with stainless steel wear surfaces, or DZR brass. For diaphragm-orifice type units, the diaphragm shall be elastomeric, with a polyphenylsulfone orifice seat. Valve’s flow and psid range shall be permanently marked on a label affixed to the flow controller. Valve assembly (not just the cartridge) shall carry a 5-year warranty (excluding union EPDM O-rings and hose liners). Shop drawing submittal shall include warranty certificate showing compliance. All 3” and smaller flow controllers and diaphragms shall be easily replaceable and removable without breaking the main piping. When a shut-off valve is shown adjacent to the flow controller, it shall not be incorporated into the flow controller / may be incorporated into the flow controller as a full port type with replaceable stems under pressure. A strainer with stainless steel 20 mesh screen and a blow-down cock with hose bib shall be incorporated in or with each flow controller assembly. This strainer is NOT to be provided if the flow controller is on the return-side of a heat exchange device and a strainer is shown/required on the supply-side. The controller shall have two pressure/temperature measurement taps. Accuracy at 3 psi differential and above shall be +/- 5 percent. Provide an 18 month cartridge exchange service to allow commissioning of the system due to pressure or flow change requirements. Flow controllers shall be manufactured by Griswold, Pro-Hydronic Specialties, Hays Fluid Controls, Nexus, NuTech, or Flow Design “Autoflow”, Bell & Gossett, Victaulic Series 76.

Note that grooved connections are only allowed if grooved piping systems have been specified for associated systems in 23 21 13.

2.6 Coil Hook-Up Packages

A. Coil hook-up packages may be provided in lieu of field assembled components, for terminal units only (not for air handling units). All components shown on the drawings and specified herein shall be provided as part of the coil hook up package. Packages shall be provided by the balancing valve / or flow controller manufacturer. When an independent shut-off valve or strainer is specified or shown, shut-off valves and stainless steel strainers of equal construction to those specified in this Section 23 05 23, including bronze or iron body, may be of same manufacturer as balancing valve / or flow controller manufacturer.

Note: Shut-off valves shall NOT be combined with other components, no exceptions.

All packages shall be pre-assembled and factory tested, packaged as individual assemblies, and plastic shrink-wrapped with tagging per shop drawings and project plans.

B. Grooved connections are only allowed if grooved piping systems have been specified for associated systems in 23 21 13.

C. Submittals shall be provided with complete documentation showing cut sheets, flow rate (GPM), pressure drop, and tagging for each device. Clearly identify supply and return hook-up devices. Also include warranty certificate for review.

2.7 Globe Valves - Nibco, Milwaukee, Watts, Apollo, Kitz, Powell, Crane

A. Type G1. Straight Pattern, 2 inches and smaller.

Nibco T-235-Y, 150 w.s.p., bronze body, screwed ends, rising stem, union bonnet, bronze seat and PTFE disc.
B. Type G3. Straight Pattern, 2 inches and smaller.
    Nibco T-276-AP, 300 w.s.p., bronze body, screwed ends, rising stem, union bonnet, S42000 stainless steel plug disc and seat ring.

C. Type G4. Angle Pattern 2 inches and smaller.
    Nibco T-335-Y, 150 w.s.p., all bronze, screwed ends, rising stem, union bonnet, renewable TFE disc.

2.8 Plug Valves - Nordstrom, Newman-Milliken, Homestead, Durco, Resun or Walworth

A. Type P1. 2 inches and smaller. Non-lubricated cock.
    Durco G432, 150 w.o.g., carbon steel with screwed ends, flat head.

B. Type P3. 2 inches and smaller. Lubricated cock.
    Nordstrom 142, 175 w.o.g., semi-steel lubricated plug cock with wrench, screwed ends.

2.9 Sweat end valves and copper-press valves of equal construction and features are acceptable in lieu of those specified with screwed ends.

2.10 Butterfly valves and ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation thickness, but minimum 2”.

PART 3 - EXECUTION

3.1 Drain valves shall be the same as for shutoff service. Provide a 0.75 inch hose thread adapter on the outlet of each drain valve that is not piped to a drainage point. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.

3.2 Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing.

3.3 Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.

3.4 Packing glands shall be tightened before placing the valves in service.

END OF SECTION
PART 1 - GENERAL

1.1 All piping shall be supported from the building structure.

1.2 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for HVAC for additional requirements.

1.3 All products and assemblies installed within the building shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other applicable manufacturers are B-line, Erico, Fee, Mason and PHD.

2.2 Hangers and supports for horizontal piping shall be equal to:

A. General service - clevis type Anvil Fig. 260.

B. Uninsulated copper tubing - copper plated clevis type - Anvil Fig. CT-65 (or plastic coated clevis).

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis, trapeze and swivel ring type hanger.

<table>
<thead>
<tr>
<th>Pipe Sizes</th>
<th>Min. Rod Dia.</th>
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<tr>
<td>2” and smaller</td>
<td>0.375”</td>
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2.4 Where the length of the hanger rod between the top of the hanger and the attachment device is 3 inches or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel.

2.5 Hanger rod attachment devices for attachment to the structure shall be:

A. Pre-set concrete inserts.

B. After-set steel expansion type concrete inserts.

C. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

D. Side beam bracket for wood construction equal to Anvil Fig. 206.

E. Channel support systems equal to Unistrut or Hilti.

F. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.6 Refer to Part 3 for steel spring and neoprene isolators in hanger rods, required for piping connecting to vibration isolated and/or motor driven equipment.
2.7 Base mounted pipe supports shall be factory or shop prime coat painted equal to Anvil catalog numbers as follows:

A. Pipe slide having carbon steel base (with guide arrangement) and inverted tee with Teflon slide plate on each - Fig. 257, type 3.

B. Base mounted pipe roller stand - Fig. 271.

2.8 Pipe riser supports shall be as follows:

A. Riser clamps on cold service piping (cold water, chilled water, refrigerant suction, etc.) - insulated pipe riser clamp assembly, Pipe Shields, Inc. E1000, with polyisocyanurate insulation, galvanized steel jacket, steel top thrust plates and steel riser clamps.

B. Riser clamps on piping other than cold service Anvil Fig. 261 except, on copper tubing, CT-121 (copper plated) or CT-121C (plastic coated).

2.9 Pipe supporting racks in tunnels shall be constructed of structural steel members, welded or bolted, Unistrut type members, or a combination thereof, assembled, braced and attached to the structure. Pipes shall be set on roller supports or neoprene or graphite pipe slide assemblies, as detailed, to allow for expansion travel. Pipe anchors and pipe guides shall be attached to the tunnel wall and not attached to the rack. Refer to the drawings.

2.10 Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension. Piping 1” and smaller and specified to be insulated with elastomeric type insulation may utilize Anvil’s 25/50 flame/smoke rated KLO-Shure strut-mounted TPO plastic insulation couplings with steel strut clamp. Insulation wall thickness shall be 0.75 thickness. Transition to required service insulation thickness within 2” of either side of coupling.

2.11 Pipe supports for pipe and conduit running across the roof shall be molded polycarbonated pillow block, UV stabilized polypropylene, or UV stabilized 100% recycled rubber pipe stands. Manufactured by Miro Industries, ABI, Inc., or Anvil H-Block. Pipe supports shall require no penetration of roofing membrane. Associated metallic hardware shall be hot dipped galvanized/304 stainless steel. Furnish protective slip sheets of roofing membrane for installation under bases.

2.12 Pipe supports for pipe and conduit running across the roof shall be manufactured by Advanced Support Products or Anvil H-Block, requiring no penetration of the roofing membrane. The support system shall consist of injection molded polypropylene, or UV stabilized 100% recycled rubber bases, 12 gauge hot dipped galvanized Unistrut framing and adjustable hot dipped galvanized or cadmium plated hangers and cadmium plated hanger rods as detailed. Furnish protective slip sheets of roofing membrane for installation under the bases.

2.13 Pipe supports for piping running across the roof shall be equal to Pate Model "PRS" roof support curb and "RAC" roller support assembly. Supports shall be heavy gauge galvanized steel roof curb with base plate, continuous welded corner seams, integral raised cant to match roof insulation (if compatible with the roofing system), wood nailer, counterflashing and roller pipe supports. Units shall be field insulated on the inside with batt insulation and attached to the roof deck.

2.14 Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, provide insulation inserts and shields as specified in 23 07 19 HVAC Pipe Insulation.

2.15 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.
PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as follows, unless otherwise shown on drawings:

   A. Steel pipe (horizontal) - 7 ft. intervals for piping 1.50 inches size and smaller, 10 ft. spacing for piping 2 inches thru 6 inches, 12 ft. spacing for larger pipe.

   B. Copper tubing (horizontal) - 6 ft. spacing for tubing 1.25 inches size and smaller, 8 ft. spacing for 1.50 inches thru 2.5 inches sizes, 10 ft. spacing for tubing 3 inches size and larger.

   C. Cast iron pipe (horizontal) - at each fitting and at each joint on straight lengths, 5 ft. maximum spacing when pipe lengths used are less than 10 ft; 10 ft. maximum spacing when 10 ft. or longer pipe lengths are used.

   D. PVC Pipe - spacing and hanging methods in strict accordance with code requirements and manufacturer’s recommendations, with consideration being given to service temperature and expansion compensation, but no greater than 4 ft. spacing for horizontal and no greater than 10 ft. spacing for vertical piping (plus midstory guide).

   E. PEX tubing – per manufacturer’s instructions but no greater than 32” spacing for horizontal and no greater than 10 ft. spacing for vertical piping (plus midstory guide).

   F. CPVC pipe or tubing (horizontal) – maximum 3 ft. spacing for 1 inch and smaller, maximum 4 ft. spacing for 1.25” and larger.

3.2 In piping systems with rolled or cut groove end pipe and mechanical joint couplings, pipe hangers shall be provided on horizontal piping at normal specified intervals and, in addition, so that no pipe shall be left unsupported between any two couplings nor left unsupported whenever a change in direction takes place. Added supports may be omitted on "rigid" couplings such as Victaulic Style 07 Zero-Flex. Vertical piping shall be supported at normal specified intervals or every other pipe length, whichever is more frequent. The base of the riser or base fitting shall be supported.

3.3 Attachment of pipe hangers to the structure shall be with:

   A. Pre-set concrete inserts in concrete construction of 4 inches minimum depth.

   B. After-set concrete inserts, in 4 inches minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

   C. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment.

   D. Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.

   E. Unistrut type channel support system may be utilized where a number of pipes are run parallel. Channel shall be pre-set or attached to the structure with inserts or clamps.

   F. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

   G. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. In the case of existing trusses, the structural engineer must review and approve pipe hanger attachment methods. Refer to the architectural and structural drawings for type of engineered
structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

3.4 The first three hangers on piping connecting to vibration isolated and/or motor driven equipment shall be fitted with vibration isolators as follows:

A. Pipe sizes less than 2” — Type J1 Vibration isolation hanger when connecting to equipment with spring isolation.
   Type J3 Vibration isolation hanger when connecting to equipment with neoprene isolation.

3.5 Pipe supports manufactured by Miro Industries / Advanced Support Products / Anvil H-Block for pipe running across the roof shall be installed in accordance with the manufacturer’s instructions and as detailed. Install protective slip sheets of roofing membrane under the bases to satisfy requirements of both the roofing manufacturer and the support system manufacturer.

3.6 Pate style support curbs shall be attached to the roof deck and flashed into roofing system.

3.7 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.8 Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within the pipe chase. Ensure that adequate support is still maintained.

3.9 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.10 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

A. MSS SP-58 on Materials, Design and Manufacturer

B. MSS SP-69 on Selection and Application

C. MSS SP-89 on Fabrication and Installation Practices

END OF SECTION
PART 1 - GENERAL

1.1 Equipment shall be supported on concrete bases, roof curbs and structural steel supports as shown on drawings or as specified. All bases, curbs and supports shall be included except as otherwise noted.

1.2 Wind Load Analysis

A. HVAC equipment, ductwork, piping, conduits, etc. exposed to wind shall have positive attachment to the building structure or ground to comply with wind load requirements of the building and mechanical codes.

B. Wind speed design shall be 90 MPH. Refer to structural drawings for additional design requirements.

C. The contractor shall retain a specialty consultant to perform wind load calculations in accordance with the code and additional requirements specified in this Section. A professional engineer experienced in wind load attachment design and installation and licensed in the state where the project is located shall be responsible for calculations, attachment selections and installation details.

D. The Wind Load Analysis consisting of attachment design, calculations, attachment selection, installation details including anchoring methods, fastener specifications, embedment and/or welded length, etc. shall be submitted for review and record. This submittal shall be signed and sealed by a professional engineer, as stated above. This submittal will become part of the project design calculations, included in the project records, and when required, will be submitted to the authority having jurisdiction.

E. The wind load attachment design shall clearly indicate the attachment points to the building structure and design forces in all horizontal and vertical axes at the attachment points. The wind load attachment engineer shall coordinate all attachments with the project's structural engineer of record, who shall verify the attachment methods and the ability of the building structure to accept the loads imposed.

F. The wind load attachment design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from submittals or the manufacturers. The equipment manufacturer shall verify that the attachment points on the equipment can accept the combination of wind load, weight, and other loads imposed.

G. At the project Engineer of Record’s discretion, equipment submittals may not be approved until the Wind Load Analysis has been submitted. It is the contractor’s responsibility to schedule and coordinate the process in a timely fashion, including follow-up Wind Analysis submittals for equipment approved pending a Wind Analysis submittal.

PART 2 - PRODUCTS

2.1 Support for equipment shall be by one or more of the following methods:

A. Structural steel angles, beams or channels, unistrut type channels or pipe. Supports shall be fabricated into a rigid framework with welded or bolted connections and cross bracing or sway bracing. Supports shall be set on slab with base plates, or attached to the building structure as required. Brackets for relatively lightweight equipment may be attached to the wall. Equipment shall be set on and attached to the framework.

B. Solid steel hanger rods supported from the structure above similar to pipe hangers. Provide sway bracing for equipment supported in this manner.
2.2 Provide exact dimensions, locations and other detail for the specific equipment provided that requires bases or supports. Set anchor bolts as required for the equipment.

2.3 Equipment roof supports shall be heavy gauge galvanized steel support curbs with base plate, continuous welded corner seams, integral raised cant to match roof insulation, internal insulation, wood nailer and counterflashing. Unless otherwise noted, top of curbs shall extend 12" above the finished roof surface, 18" above for intake applications. For sloped roofs, the curb shall have a built-in slope to match roof slope so that top of curb is level.

2.4 Rooftop heating cooling units shall be roof curb mounted. Curbs shall be furnished with the equipment and meet the following requirements:

A. The roof curb shall be 24" minimum height / or height required to make outside air intake minimum 36" above the highest surface of the roof, whichever is greater. Gasketing shall be furnished for field installation to ensure a weather-tight condition. For sloped roofs, the roof curb shall be sloped to match the roof slope to provide a level unit support. The roof curb shall be consistent with the footprint of the unit, including the piping cabinet and other unit components.

B. Minimum 2" continuous internal insulation.

2.5 Refer to 23 34 00 HVAC Fans for roof curb requirements associated with that equipment.

PART 3 - EXECUTION

3.1 Roof support curbs shall be installed and leveled and secured to the roof deck/structure. Roof insulation and roofing shall be installed at the curbs by the roofing Contractor. Provide wood cant strips around the curb only if recommended for the roofing system.

3.2 Bracing and Attachment

A. All equipment and curbs exposed to wind shall be installed and attached to structure in strict accordance with the wind load attachment design provided by the engineer to conform with requirements of the Code and referenced standards and in strict accordance with the manufacturers written instructions.

B. No rigid connections between equipment and the building structure shall be made that would degrade noise and vibration control.

C. Coordinate work with other trades. When conflicts develop in installation, they shall be brought to the attention of all involved parties and a suitable solution must be determined.

D. Each manufacturer of equipment shall furnish a statement stamped by a professional engineer indicating that the equipment is designed and constructed to withstand wind loads required by the code. Statement shall be based on analysis, testing or experience data, and supporting documentation shall be available upon request.

END OF SECTION
HVAC EQUIPMENT DRIVES

PART 1 - GENERAL

1.1 Belt driven equipment shall be provided with pulleys and drive belts as specified and as required for the service.

1.2 Exposed pulleys, belts, drives and couplings shall be protected with guards in accordance with OSHA requirements.

1.3 Unless noted otherwise adjustable frequency motor controllers (VFD’s) shall be provided under Division 23. Refer to specification section 23 05 14 Adjustable Frequency Motor Controllers.

PART 2 - PRODUCTS

2.1 Drive belts shall be “V” type unless another design is standard for the equipment manufacturer. Belt drives shall have a capacity rating of at least 150 percent of the motor horsepower.

2.2 Drive pulleys shall be adjustable unless a fixed pulley is specified. Adjustable drive pulleys shall be selected near the mid-point of range.

2.3 Drive guards in the air stream of fans shall be flattened expanded metal which does not appreciably restrict air flow.

PART 3 - EXECUTION

3.1 Pulleys and belts shall be aligned, pulleys adjusted and belt tension set for proper operation and specified duty.

3.2 Provide a drive change-out (sheaves, pulleys and, if necessary, belts) when, during final air balancing, it is deemed necessary to attain the specified air quantity and/or the desired performance. The Engineer shall have final say as to whether or not a drive change-out is required.

END OF SECTION
IDENTIFICATION OF HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 Identification of Division 23 equipment shall consist of equipment labeling, pipe and duct marking and valve tagging as specified hereinafter.

1.2 Each item of major equipment shall be labeled. This shall include compressors, VAV boxes, roof top units, fans, condensers, and other similar equipment.

1.3 Pipe markings shall be applied to all piping.

1.4 Duct markings shall be applied to all ductwork.

1.5 Underground exterior piping shall be identified with a continuous plastic line marker tape as described in the service piping sections and this section.

1.6 Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8.50 inches x 11 inches paper, tabulating valve number, piping system, system abbreviation, location of valve (room or area) and service (e.g. - South wing reheat boxes).

1.7 Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

1.8 Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.9 Submit product data noting materials, sizes and dimensions for identification systems.

PART 2 - PRODUCTS

2.1 Equipment labeling shall be either, or a mix, of the following:

   A. Permanently attached engraved brass or plastic laminated signs with 1 inch high lettering. Signs on exterior equipment shall be brass.

   B. Stencil painted identification, 2 inches high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 Pipe markings shall be:

   A. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color-coded pipe markers extending fully around the pipe and insulation.

   B. Non-metallic piping that is insulated for plenum rating purposes shall be labeled with White letters on Brown background. Labeling shall state “INSULATION REQUIRED FOR PLENUM RATING – DO NOT REMOVE”.

   C. On piping and insulation 6 inches and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1.50 inches wide, full circle at both ends of the marker.

   D. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.
2.3 Duct markings shall be laminated plastic color-coded pressure sensitive vinyl tape, 2.50 inches width, 3 mils minimum thickness. Identification shall include service (supply, return, exhaust, outside air) and direction of flow.

2.4 Duct access door and panel markings shall be similar to duct markings to identify the device (FIRE DAMPER, SMOKE DAMPER, FIRE/SMOKE DAMPER, CONTROL DAMPER, SMOKE DETECTOR, etc.).

2.5 Underground line marker tape shall be permanent bright-colored, plastic with continuous identification lettering. Tape over service lines that cannot be detected by a metal detector shall be multi-ply with an aluminum foil core.

2.6 Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with "H" (for HVAC) and the designated number.

2.7 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after insulation and painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled on drawings.

3.3 The Contractors shall coordinate labeling, marking and tagging to attain coordinated and consistent systems of identification.

3.4 Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust fan labeling shall also indicate service or room or area of service.

3.5 Pipe and duct markers shall be placed:

A. At each piece of equipment.

B. At 25 ft. centers in mechanical rooms and concealed spaces, but at least once per room.

C. At 50 ft. centers in exposed finished areas, but at least once per room.

D. On mains at each branch take-off.

E. On duct access panels.

3.6 Refer to appropriate sections of this specification for installation of underground line marker tape.

3.7 Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above. Copies of one set of schedules shall be framed under glass or plastic / laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION
PART 1 - GENERAL

1.1 Provide air and water balancing of the new systems affected by the new work. Balancing work shall be performed by insert 2 or 3 balancing contractor’s names here or qualified personnel of a member firm of the Associated Air Balance Council (AABC) or a member firm of the National Environmental Balancing Bureau (NEBB), who has no affiliation with the Contractor or any of its Sub-Contractors. Include a certification sheet signed and sealed by the certified testing and balancing authority. Include a list of instruments to be used for procedures, along with proof of calibration.

1.2 Methods, procedures, equipment, certifications, report forms and reporting information shall be in accordance with the standards of AABC or NEBB and latest edition of the SMACNA TAB Procedural Guide and industry practice.

1.3 During the bid period, call to attention any requirements for additional balancing dampers, test ports, gage cocks, thermometer wells, flow control devices, valves, balancing valves and fittings and manual volume dampers which are deemed necessary in addition to those shown on the drawings, and provide such so that proper balancing can be performed. Prior to installation of the systems, verify that the proper number and location of balancing devices are adequate for completion of the balancing work.

1.4 Prepare a balancing plan that includes strategies and step-by-step procedures. This plan should include a list of items that must be completed before balancing can proceed. Prepare a schedule to ensure adequate time for the balancing process and submit this schedule to the Architect for review.

1.5 When project is in phases and partial occupancy is planned, determine process to allow balancing work to be completed before occupancy.

1.6 Refer to Section 23 05 31 HVAC Equipment Drives and other Sections of Division 23 for requirements related to the balancing work.

1.7 Verify that all equipment start-up services have been completed before the beginning of any balancing work. After initial start-up has been completed, inform the balancer that the systems are operating properly, that all safety interlocks and protective devices are functioning, and the systems are ready to be balanced. Refer to SMACNA Guide 2.6.1 for items to be included in system check.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Air Balance

A. Obtain job specific fan curves for each fan being balanced, new and existing, and include in report.

B. Record nameplate data from fan, motor, and air handling cabinet.

C. Record and measure fan and motor sheaves indicating number and size of belts along with center-to-center distances.

D. Test and record actual operating fan rpm.

E. Measure and record actual running amperage.
F. Each air supply, return, and exhaust system, when installation is completed, including the installation of clean filters, shall be set in operation for balancing. Determine the best location in main and branch ducts for accurate duct airflow measurements. Each air outlet and inlet device, item of equipment (fan coils, air control units, etc.), shall be balanced to the quantities listed on the drawings within plus or minus 10 percent, except when more stringent requirements are required as defined below. Central fan systems (AHU's, exhaust fan systems, etc.) shall be balanced to within plus or minus 5%. Intended pressure relationships in areas required by recognized standards and practice shall be attained.

G. Adjust drive pulleys to attain fan speed required for the installed condition. Upon final determination of proper operating speed adjustable pulleys shall be removed and replaced with fixed pitch pulleys. Pulleys and belts of fixed drives and of adjustable drives not having sufficient adjustment range shall be changed out, at the direction of the balancer or Engineer, to obtain fan speed required for the installed condition. Labor /or materials required to make the recommended changes shall be included in Division 23.

H. Measure velocity reading across coils, filters, and dampers on the intake side of the fan. Include data in the report.

I. Coordinate with the Temperature Controls Installer in setting supply and return fan inlet vanes and outside air, return air and vent air dampers. Supply air systems shall have ampere reading measured in the full heating, full cooling and economizer modes to determine the maximum brake horsepower.

J. Witness all duct pressure and leakage tests. Refer to 23 31 13 and coordinate accordingly.

K. Total air quantities of the supply fan, and the return fan, exhaust fan shall be determined by pitot tube traverse. Where impossible to take good pitot tube traverses of duct system, use total sum of terminal device air volume readings. Final settings of fan speeds shall be determined with automatic volume control devices at the fans fully open / variable speed drives at full speed. Refer to item F. above for drive changeout requirements and the items below.

L. For variable-air-volume systems, develop and implement a plan to simulate diversity.

M. Check airflow patterns from the outside-air louvers and dampers and the return and exhaust-air dampers, through the supply-fan discharge and mixing damper. Report any issues with stratification, poor mixing or short circuiting from one air stream to the other.

N. Check for airflow blockages.

O. Check for proper sealing of air-handling unit components. Report all issues in balancing report.

P. Check for proper sealing of air duct systems. Minor issues shall be reported in the balancing report. If a major issue is found, stop balancing work and report issue to the Engineer.

Q. In balancing of variable air volume systems, the total air quantity of the devices generally exceeds the fan air quantity due to the nature of the VAV system. The fan speed shall be set to deliver the required maximum fan cfm (not the total cfm of all of the devices) with duct static pressure sufficient (and yet not excessive) for proper operation. Terminal air control units shall be repositioned for fan balancing to deliver the maximum fan cfm. When dual minimum control sequence is specified, setup the heating and cooling minimums.

R. Balancing of terminal air control units and air devices shall be done to provide adequate but not excessive pressure in the branch ducts to air control units and air devices. Dampers incorporated in air devices shall be used only as secondary balancing means when other branch dampers are provided. Check, test and calibrate as required all terminal air control
unit cfm settings (maximum, minimum). Also, record static pressure drop across the air control unit and reheat coil.

S. The report shall include, but not be limited to, fan curves, both actual and design fan cfm, rpm, brake HP, entering and leaving static pressures, motor data, voltage and amperage and drive information. System air flows by device, terminal, branch and system shall be reported.

In addition, a sketch shall be provided for each air system balanced or surveyed, depicting exact location that fan static pressure and fan CFM readings were taken, relative to fan inlet and discharge, and what duct accessories were in place near the reading location and between the reading location and the fan. The sketch shall also depict elbows and other duct transitions in place near the reading location and between the reading location and the fan. Air handling unit sketches shall depict all air path components within the unit, and static pressure readings across each item. Balance reports will be rejected without this information.

T. Mark equipment and balancing device setting with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-controls levers, and similar controls and devices, to show final setting.

U. Pressurization measurements shall not start until the space has been observed to verify the integrity of the space boundaries. Test should measure, adjust and record the pressurization of each room, each zone and each building. If building is being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.

3.2 Water Balance

A. Each new and existing water circulating system, when installation is completed, shall be set in operation for balancing. Water flow thru each pump, chiller, coil, heat exchange device, balancing valve and water flow meter shall be determined by pressure differential gauging or direct reading. Automatic Flow Controllers at all air handling unit coils shall have flows verified via differential pressure, and 25% / 50% / 100% of all other automatic flow controllers shall be documented as well. Automatic flow controller documentation shall include Valve Model Number, shop drawing Dp Range and GPM, and actual Differential Pressure reading. Pressure Independent Control Valves at all air handling unit coils shall have flows verified via differential pressure, and 25% / 50% / 100% of all other PIC Valves shall be documented as well. PIC Valve documentation shall include Valve Model Number, Setting, shop drawing Dp Range and GPM, and actual Differential Pressure reading.

Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Flows shall be balanced to quantities listed on the drawings within plus or minus 5 percent.

B. Check and compare expansion tank set-up data to design requirements for proper operation. Report any deviations to the Engineer for corrective action.

C. Check makeup-water-station pressure settings for adequate pressure.

D. Check flow-control valves and set to indicated flow.

E. Verify air has been vented from system. Check air vents for a forceful liquid flow exiting from vents when manually operated.

F. Obtain job specific pump curves for each pump, new and existing, and include in report. Verify pump data - pump-motor brake horsepower and impeller size on nameplate data on the pump to design submittals.

G. Pump tests shall show full flow and dead head conditions. Do not throttle valves on the pump discharge. Pump flow control valves shall not be closed more than fifty percent. Pump flow
control valves, which require more than fifty percent closure shall be reported to the engineer for evaluation of valve sizing and selection. Automatic valves shall be fully open during testing of the unit associated with the control valve.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads and systems' pressures and temperatures including outdoor air temperature.

I. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

J. Water Coils: Record water flow rate and water pressure drop.

K. The report shall include, but not be limited to, pump curves, both actual and design water quantities, pressures in and out of each device, pump motor data, operating voltage and amperage and pump curves.

L. Mark equipment and balancing device setting with paint or other suitable, permanent identification material, including valve-control positions, valve position indicators and similar controls and devices, to show final setting.

3.3 Measurement of Vibration: Measure and record vibration on supply and return fans.

3.4 Submit procedures for testing IAQ quality measurements when required. Follow SMACNA IAQ Testing Procedures latest edition.

3.5 After completion of the balancing work, a full report shall be prepared in pencil and two copies (only) submitted to the Engineer for preliminary review. After review, additional balancing, adjustments, drive replacements, readings and recordings deemed necessary shall be done and the report revised. Six typed copies of the final report shall be submitted to the Engineer for review and approval. An approved copy of the report shall be included in each set of operating and maintenance manuals.

3.6 Final Report contents: In addition to certified field report data, include the following:

A. Table of Contents with total number of pages defined for each section of the report.

B. Summary of Contents - include the following:
   1. Indicated versus final performance.
   2. Notable characteristics of systems.
   3. Description of system operation sequence if it varies from the contract documents.
   4. Flow meter readings versus associated gpm readings of associated pump(s) and/or balancing valve(s), at same point in time.
   5. Scheduled flow meter water pressure drop versus actual w.p.d.

C. Nomenclature sheets for each item of equipment.

D. Notes to explain why certain final data in the body of reports varies from indicated values.

E. Pump Curves.

F. Fan Curves.

G. Manufacturers’ test data.

H. System component diagrams including schematic layouts of air and hydronic equipment. Present each in single-line format with data points indicated.
I. When performed, include vibration measurement, IAQ measurement reports.

3.7 Inspection after testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance reading documented in the final report. Submit random sampling percentages and results.

3.8 10 Month Warranty Walk: Perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to report unusual conditions with recommendation of adjustments. Allow 1 days for this work.

END OF SECTION
PART 1 - GENERAL

1.1 All interior and exterior supply air, mixed air, and intake outside air ductwork and plenums shall be insulated unless specifically noted as “uninsulated” in the Duct Construction Schedule on the drawings, including ductwork in crawl spaces, attics, and buried under slab.

1.2 All interior and exterior return air ductwork and plenums shall be insulated unless specifically noted as “uninsulated” in the Duct Construction Schedule on the drawings, including ductwork in crawl spaces, and attics (when duct is above the roof insulation).

1.3 Unless noted otherwise below, exhaust and relief air ductwork shall be insulated from 24” upstream of the auto/backdraft damper to the point of exterior wall/roof penetration.

1.4 Equipment and devices, accessories and stiffeners in insulated ductwork shall also be insulated. This includes but is not limited to external duct bracing and stiffeners, duct coils, air terminal reheat box coils, air control dampers and valves, fire dampers, smoke dampers, filter housings.

1.5 Required internal lining is indicated on the Duct Construction Schedule on the drawings. Refer to section 23 31 13 – HVAC ductwork and coordinate with the various trades.

1.6 Composite insulation assemblies shall meet UL 723 or ASTM E84 requirements and not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, and “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84. Identification of manufacturer, thermal resistance (R-value), flame spread and smoke-development shall be clearly marked on the exterior of the insulation at intervals as required by code.

1.7 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.8 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage, in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Insulation shall be manufactured by Johns Manville, Owens Corning, Certainteed, Knauf, Manson, or as listed below. Insulation for duct systems required to be insulated shall have a minimum installed R-value of 4.2 (at a 75 degrees F mean rating temperature) except as noted below:

<table>
<thead>
<tr>
<th>Duct System</th>
<th>Minimum Installed R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply air and return air located outdoors</td>
<td>R-6.0 (1)</td>
</tr>
</tbody>
</table>

Notes:
(1) Listed R-value may be a total R-value for internal insulation plus external insulation. Refer to Duct Construction Schedule on the drawings.
“Installed” R-value for blanket insulation is the calculated R-value with 25 percent compression. “Installed” R-value for board insulation is the published nominal R-value.

2.2 Insulation on concealed ductwork shall be fiberglass blanket insulation with factory applied reinforced foil and kraft paper vapor barrier jacket, minimum 1.50 inches thickness and 0.75 inch p.c.f. density, formaldehyde-free or GreenGuard Certified for low formaldehyde and VOC emissions.

2.3 Insulation on exposed ductwork shall be fiberglass board insulation with factory applied “all service” jacket with vapor barrier, minimum 2 inches thickness and 3 p.c.f. density, formaldehyde-free or GreenGuard Certified for low formaldehyde and VOC emissions.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers’ recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of ductwork and fittings has been completed prior to installing insulation.

3.3 Installation

A. Installation shall be done by tradesmen specializing in this work in strict accordance with manufacturer’s recommendations.

B. Install all insulation materials and accessories in accordance with manufacturer’s published instructions and recognized industry practices. External duct stiffeners and bracing shall be insulated same as for duct.

C. Blanket insulation shall be wrapped tight to the duct. Insulation shall be secured to ducts 20 inches wide and greater with weld pins and fasteners, 18 inches on center maximum. Adhesive shall be applied to the duct as an aid to installation and adhesion. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3 inches wide FSK pressure sensitive tape.

D. Board insulation with factory applied jacket shall be secured to the duct with weld pins and fasteners, 12 inches on center maximum. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3 inches wide ASJ pressure sensitive tape.
E. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. All staples used on cold insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

F. External insulation on supply /, exhaust / and return ductwork located outdoors shall be weatherprotected with field applied metal jacket. Tops of ducts shall be pitched to drain, and the jacket shall be firmly attached and secured, and over-lapping joints and seams shall be silicon caulked watertight. Longitudinal seams shall be located on the bottom.

3.4 Protection

A. Advise as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

END OF SECTION
23 07 19 HVAC PIPE INSULATION

PART 1 - GENERAL

1.1 Piping systems shall be insulated as described below in their entirety, including pipe, fittings, unions, flanges, mechanical joint couplings, pump casings, air and/or dirt separators, valves, devices, specialties and all related items and equipment unless otherwise noted. Maintain access to covered P/T test ports, strainer caps, air vents, and similar accessories thru the use of removable and reusable caps, plugs and fittings.

1.2 Composite insulation assemblies shall not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

1.3 The following HVAC piping shall be covered with insulation of thickness listed, to meet or exceed ASHRAE 90.1, latest publication:

<table>
<thead>
<tr>
<th>Pipe System</th>
<th>.75” and smaller</th>
<th>1.0” to 1.25”</th>
<th>1.50” to 3”</th>
<th>4” to 6”</th>
<th>8” and larger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot water, above 200°F (1)</td>
<td>2.5”</td>
<td>2.5”</td>
<td>2.5”</td>
<td>3”</td>
<td>3”</td>
</tr>
<tr>
<td>Hot water, 141°F to 200°F (1)</td>
<td>1.5”</td>
<td>1.5”</td>
<td>2”</td>
<td>2”</td>
<td>2”</td>
</tr>
<tr>
<td>Hot water, 105°F to 140°F (1)</td>
<td>1”</td>
<td>1”</td>
<td>1.50”</td>
<td>1.50”</td>
<td>1.50”</td>
</tr>
<tr>
<td>Chilled water (2), 40°F and above</td>
<td>0.50”</td>
<td>1”</td>
<td>1”</td>
<td>1.50”</td>
<td>1.50”</td>
</tr>
<tr>
<td>Chilled water (2), below 40°F</td>
<td>1.5”</td>
<td>1.50”</td>
<td>1.50”</td>
<td>1.50”</td>
<td>1.50”</td>
</tr>
</tbody>
</table>

Notes:
1. For piping 1.50” and smaller located in vertical partitions within conditioned spaces, insulation thickness may be reduced by 1”, but resultant insulation thickness shall be no less than 1” thick. Indoor steam vent piping from receivers, flash tanks, deaerators, and other normally active vented equipment shall be insulated with 1.5” thick insulation. Boiler surface blowdown piping with-in 7 ft of the floor shall be insulated with 1” thick insulation for personnel protection.
2. Chilled water - including glycol solution as well as clear water.
3. Cooling condensate drainage – from cooling coil drain pans, associated floor drain sumps, traps and horizontal above ground piping to vertical stack (coordinate with plumbing).
4. Insulate refrigerant liquid line when recommended or required by equipment manufacturer (such as for variable refrigerant volume / flow systems).
5. Steam condensate -- includes pumped condensate, transfer condensate (downstream of surge tanks), and condensate downstream of flash tanks.
6. Pressurized Steam Condensate – includes condensate that is downstream of heat exchange equipment, boiler feedwater, and condensate that is downstream of steam traps.

1.4 Insulation on HVAC systems is to be omitted on:

A. Unions in hot water piping, steam piping, and steam condensate piping.
B. Strainers, control valves, balancing valves, and automatic flow controllers in hot water piping 1” and smaller.
C. Hot water piping in cabinetry of air terminal boxes, unit heaters.
1.5 Insulation for hot water piping connecting to duct coils and air terminal unit coils shall include a vapor barrier maintained from the coil to 6” from the coil.

1.6 Devices in hot water piping 1.25” and larger (including valves, strainers, specialties, and accessories) connecting to duct coils and air terminal unit coils shall remain uninsulated for ease of access, and fitted with removable re-usable covers as described in 2.16.

1.7 Mechanical joint fittings and couplings shall be considered as a part of the pipe line and shall be insulated. Bidders on the insulation work are cautioned to verify during the bidding period the extent of this work.

1.8 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.9 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Unless specified otherwise, pipe insulation shall be factory molded tubular fiberglass with “all service” jacket having an integral vapor barrier as manufactured by Johns Manville, Owens Corning, Knauf, Manson or as otherwise specified below. Longitudinal joints of the jacket shall be overlapping with factory applied adhesive. In lieu of the factory adhesive, staples on 6 inches centers may be used with vapor barrier mastic applied to seal both the joint and staple holes. Butt joints shall be sealed with 3 inches wide ASJ pressure sensitive tape. Insulation shall be GreenGuard Certified for low formaldehyde and VOC emissions. Outdoor piping shall be jacketed as specified below. Thermal conductivity (k) shall be as specified below:

<table>
<thead>
<tr>
<th>Maximum Conductivity k</th>
<th>Mean Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTU in / (h x ft² x °F)</td>
<td>Temp degrees F</td>
</tr>
<tr>
<td>0.34</td>
<td>250</td>
</tr>
<tr>
<td>0.32</td>
<td>200</td>
</tr>
<tr>
<td>0.30</td>
<td>150</td>
</tr>
<tr>
<td>0.29</td>
<td>125</td>
</tr>
<tr>
<td>0.28</td>
<td>100</td>
</tr>
</tbody>
</table>

2.2 Closed cell elastomeric insulation for above grade use on systems operating at 200 degrees F and below and 6 inches or smaller pipe sizes shall be tubular closed cell pipe insulation, pre-slit longitudinally. Polylefin insulation is not acceptable. Insulation shall be manufactured without the use of CFC’s, HCFC’s or HFC’s. It shall meet ASTM C534 and also be formaldehyde free, low VOC, dust free, resistant to mold and mildew, and shall be 25/50 rated per ASTM E84. Thermal conductivity (k) shall be maximum 0.27 at 75 degrees mean rating temperature.

Closed cell elastomeric insulation shall be Armacell AP/Armaflex SS, K-Flex USA “Insul-Tube” or Aero Flex USA “Aerocel-SSPT”. For systems operating at 180 degrees F or less, insulation shall utilize a self-sealing pressure sensitive closure system. Butt joints shall be sealed with Armaflex
520 BLV low VOC adhesive or equal. For systems operating between 180 degrees F and 200 degrees F, all joints and seams shall be sealed with Armaflex 520 BLV low VOC adhesive or equal.

For indoor systems, use shall be restricted to those systems requiring 2 inch thickness or less (due to 25/50 ASTM E-84 requirements).

Unless jacketed, for insulation located outside field paint with minimum 2 coats of an appropriate paint as recommended by the insulation manufacturer to prevent solar ultra-violet deterioration.

2.3 Closed cell elastomeric insulation for above grade use on piping systems larger than 6 inches and operating at 200 degrees F or less shall be Armacell AP / Armaflex sheet wrap thru 1” thick, and AP / Armaflex FS sheetwrap for 1.5 inch and 2 inch thickness, or equal by K-Flex USA or Aero Flex USA. Polyolefin insulation is not acceptable. All joints and seams shall be sealed with Armaflex 520 BLV low VOC adhesive, or equal. Insulation shall meet ASTM C534 and be manufactured without the use of CFC’s, HCFC’s or HFC’s. It shall also be formaldehyde free, low VOC, dust free, resistant to mold and mildew, and shall be 25 / 50 rated per ASTM E84. Thermal conductivity (k) shall be maximum 0.27 at 75 degrees F mean rating temperature.

Unless jacketed, for insulation located outside, field paint with minimum 2 coats of an appropriate paint as recommended by the insulation manufacturer to prevent solar ultra-violet deterioration.

For indoor systems, use shall be restricted to those systems requiring 2 inch thickness or less (due to 25 / 50 ASTM E-84 requirements). For outdoor systems, 1.5 inch and 2 inch thickness AP / Armaflex may be used.

2.4 Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with any of the following (except when removable insulation covers are specified):

A. For fiberglass insulation;
   1. Factory molded fitting insulation cover with PVC one-piece fitting cover;
   2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover;
   3. Fiberglass blanket insulation, held in place and covered with PVC one-piece fitting cover.
   4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.

B. For closed cell elastomeric insulation systems:
   1. Miter cutting of tubular insulation using special tools and mitering devices; or
   2. Oversized pipe insulation overlapped and shaped to conform to fitting, valve or device.

C. For cellular glass insulation systems:
   1. Machined or factory fabricated segments.
   2. Hand carved, subject to approval by the Engineer.

2.5 Hangers on insulated horizontal piping are to be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:

A. Pipe 2 inches and smaller  Anvil Fig. 168, 18 ga. sheet metal rib-lock shield with belled ends, 12 inches long.

2.6 Insulation saddles shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.
2.7 For systems specified to have protective jacketing, jacketing shall be 0.016 inch aluminum / 0.010 inch stainless steel / 0.020 inch PVC sheet with special Z-joint closure and factory supplied snap-straps. Joints and seams shall be sealed watertight.

2.8 For systems specified to have protective jacketing, jacketing shall be VentureClad 13-ply 1579 CW / 5-ply 1577 CW self-adhesive laminate, or equal by Foster Products. Color shall be white.

2.9 Mechanical joint fittings and couplings shall be considered as a part of the line and shall be insulated. Bidders on the insulation work are cautioned to verify during the bidding period the extent of this work.

PART 3 - EXECUTION

3.1 Site Inspection
   A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.
   B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers’ recommendations.
   C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation
   A. Ensure that all surfaces over which insulation is to be installed are clean and dry.
   B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.
   C. Ensure that pressure testing of piping and fittings has been completed prior to installation.

3.3 Installation
   A. Installation shall be done by tradesman specializing in insulation work in strict accordance with manufacturers’ recommendations. Installers shall be factory trained and certified for the insulation systems being installed. Submit credentials upon request.
   B. Install all insulation materials and accessories in accordance with manufacturer’s published instructions and recognized industry practices.
   C. Install insulation on piping subsequent to installation of heat tracing and acceptance tests.
   D. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal, including over staples.
   E. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic. Except in ceiling spaces, PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.
F. Insulation on cold service piping shall be run thru floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to the 23 05 07 Piping Materials and Methods for special considerations which must be given at fire rated wall and floor penetrations. Refer to Section 23 05 29 Hangers and Supports for HVAC Piping for non-compressible insulation or blocking material and sheet metal saddles required at pipe hangers. Refer to Section 23 05 23 General Duty Valves for HVAC Piping for valves requiring extended shaft necks. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.

G. Provide removable insulation sections to cover parts of equipment which must be opened periodically or maintenance, and for cooling condensate piping clean-outs.

H. Items such as ASME stamp and manufacturers' nameplates, may be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of those items. Provide neatly beveled edges at interruptions of insulation.

I. Self-adhesive laminate jacketing shall be installed in strict accordance with manufacturer's instructions.

3.4 Protection

A. Advise as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.6 Reinsulate piping where existing insulation has been damaged or removed in the performance of work in this project.

END OF SECTION
PART 1 - GENERAL

1.1 Overview

A. Furnish all labor, materials and equipment necessary for a complete and operating Building Automation System (BAS), utilizing direct digital controls and pneumatic / electric actuation as shown on the drawings and as described herein. Drawings are diagrammatic only.

B. The school has an existing LON controls network provided by ASA Controls. All work is to be integrated into the existing controls network. Coordinate exact requirements with existing DDC architecture, including graphics, naming conventions, and user interface.

C. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed over the control system network, the Owner’s local area network, and remotely over the Internet (through the Owner’s LAN).

D. Performance Monitoring: The BAS will provide the specified performance monitoring functionality, including required monitoring points and performance metrics, improved through system accuracy, data acquisition and data management capabilities, and required graphical and data displays.

E. The intent and requirement of this specification and related sections is to provide a fully integrated, open, interoperable, peer-to-peer, networked, and distributed BAS. The following communication protocols are acceptable:

1. ANSI/ASHRAE Standard 135 LONWorks - A Data Communication Protocol for Building Automation and Control Networks
2. MODBUS Application Protocol V1.1b (applicable to factory packaged equipment controllers only)
3. Tridium Niagara Framework Protocol
4. Internet Engineering Task Force RFC 7540 Hypertext Transfer Protocol HTTP/2

F. The BAS shall be comprised of:

1. Communications Network
2. Embedded Controller/Web Server(s)
3. Graphical User Interface
4. Equipment controllers (B-AAC, B-ASC, MEC)
5. Sensors (refer to Section 23 09 25)
6. Controlled devices (refer to Section 23 09 25)

G. Software License Agreement

1. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract, and shall give him and his authorized agent full access to all features and functions of the installed BAS. Such license shall grant use of all programs and application software to Owner and his authorized agent as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

2. It is the Owner’s express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This
shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the Enterprise Network Server, Embedded Controller/Web Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner. The owner shall determine which organizations to be named in the SI organization ID (“orgid”) of all software licenses. Owner shall be free to direct the modification of the “orgid” in any software license, regardless of supplier, by Tridium Inc.

H. All Embedded Controller/Web Servers shall be accessed via a single connection to the Enterprise Network Server. In this configuration, each Embedded Controller/Web Server can be accessed from a PC using Remote Desktop Connection Client User Interface and from a PC using Web Browser Client User Interface.

I. Local connections shall be via an Ethernet LAN. Remote connections shall be via Owner provided full-time, high-speed ISP connection for remote site access (i.e., T1, ADSL, cable modem) and IPv6 compliant. The owner shall be responsible for all monthly internet access fees and connection charges.

J. The basic control system includes all sensors, controllers, instruments, valves, actuators, devices, installation and service for a complete and functional control system. All control devices (valves, dampers, actuators, etc.) and associated power and control wiring shall be included. Refer to Section 23 09 25 Instrumentation and Control Devices for HVAC and Section 23 09 47 Control Power and Wiring for HVAC. The BAS shall be designed to allow easy field adjustment of all set points and parameters.

K. Provide for future system expansion to include monitoring of the access, intrusion detection, fire alarm, and lighting control systems.

L. Identify active or inactive pneumatic tubing, control wiring, equipment, etc., and where requested assist in the actual removal. Remove all pneumatic tubing, control wiring, and control devices not required to accommodate the new control system.

1.2 Provider Requirements

A. Manufacturer Qualifications

1. All products used in the installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. The installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be made available for at least 10 years after completion of this contract.

B. Installer Qualifications

1. Installing Contractor shall have an established working relationship with Control System Manufacturer of not less than 5 years.
2. Installing Contractor and his Sub-Contractors shall have successfully completed manufacturer’s control system training. Provide certification of completed training, including hours of instruction and course outlines, within 10 days after bid date.
3. Installing Contractor shall have an office within 75 miles of the project site and provide 24 hour response in the event of a customer call, 7-days per week, 365 days per year.

1.3 Approved Control System Manufacturers and Installing Contractors

A. Embedded Controller/Web Server products utilizing Niagara Framework by Tridium Inc. are the basis of design.
B. Any material or equipment that will fully perform the duties specified will be considered ‘equal,’ provided the bid submits proof that such material or equipment is of equivalent substance and function and is approved, in writing. Requests for the approval of ‘or equal’ shall be made in writing at least five business days prior to bid opening. During the bidding period, all approvals shall be issued by the Architect/Engineer in the form of addenda at least two business days prior to the bid opening date.

C. The following control system Manufacturers’ products that are LONWorks compliant are pre-qualified:
   1. Siemens Building Technologies, Inc. – Talon (N4)
   2. Honeywell International – WEBs (N4)
   3. Schneider Electric I/A Series

D. The following Installing Contractors are pre-qualified:
   1. ASA Controls, Inc.
   2. Comfort Systems USA
   4. Point To Point Systems
   5. MSD

E. Any Manufacturer or Installing Contractor not pre-qualified above shall submit credentials for the Engineer's review seven or more days prior to the bid date. Applications submitted after seven days prior to the bid date will not be considered. Credentials must attest that the manufacturer and installer meet all requirements above. The Engineer's judgment in reviewing any manufacturer or contractor will be final.

1.4 Technical Proposal

A. Provide a technical proposal to the Engineer after bidding and before award of a contract when so requested by the Engineer. The Engineer's review comments will be made available to the bidder two weeks after receipt of the technical proposal. The technical proposal shall contain the following:

   1. Description of how the system meets and achieves the specified criteria in terms of configuration, operation and control.
   2. BAS single line riser diagram, showing all major components (digital controllers, bus network, etc.).
   3. Procedure and amount of time required to start up the system.
   4. Bidder shall explain:
      a. How Owner programs (language, etc.) the system.
      b. Any proprietary software for which documentation is not available.
      c. Manufacturer of major components.
      d. Requirements of the off-site data terminal to access to BAS over telephone communications.

B. For all application programs supplied, bidder shall explain in the technical proposal, program constraints and limitations, and listing of all systems the program is applied to, including digital controller interface and control of:
   1. Typical air handling unit.
   2. Hot water and steam systems control.
   3. Chilled and condenser water systems control.
   4. Smoke management systems.

C. An interview may be conducted and each bidder will be requested to make a presentation concerning the system proposed.

1.5 Codes and Standards
A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities’ codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions of the following codes and standards:

1. National Electric Code (NEC)
2. Ohio Building Code (OBC) and Ohio Mechanical Code (OMC)
3. National Fire Protection Association (NFPA)
4. Ohio School Design Manual (OSDM)
5. ANSI/ASHRAE Standard 55 Thermal Environmental Conditions For Human Occupancy
6. ANSI/ASHRAE Standard 62 Ventilation For Acceptable Indoor Air Quality
8. ANSI/ASHRAE Standard 135, LONWorks - A Data Communication Protocol for Building Automation and Control Networks
9. Underwriters Laboratories: Products shall be UL-916-PAZX Listed
10. Underwriters Laboratories: Products shall be UL-864-UUKL Listed

1.6 The following sections constitute related work:

A. Section 23 09 25 – Instrumentation and Control Devices for HVAC
B. Section 23 09 47 – Control Power Wiring for HVAC
C. Section 23 09 93 – Sequence of Operation for HVAC Controls / For Sequence of Operations for HVAC Controls refer to drawings.
D. Section 23 09 95 – Direct Digital Control System Points List / For Points Lists refer to drawings.

1.7 System Performance

A. Performance Standards. System shall conform to the following minimum standards over network connections:

1. Graphic Display. A graphic with 20 dynamic points/objects shall display with current data within 10 seconds.
2. Graphic Refresh. A graphic with 20 dynamic points/objects shall update with current data within 8 seconds.
3. Object Command. Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.
4. Object Scan. Data used or displayed at a controller or user interface shall have been current within the previous 6 seconds.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the user interface within 45 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 second. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute BAS PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciations. Each user interface on the network shall receive alarms within 5 seconds of other user interfaces.
9. Reporting Accuracy. System shall report values with the minimum end-to-end accuracy listed in Table 1 of Section 23 09 25 Instrumentation and Control Devices.
10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2 of Section 23 09 25 Instrumentation and Control Devices.

1.8 Submittals
A. Refer to Section 23 05 01 – Basic HVAC Requirements /and Division 1.

B. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2009 (or newer) compatible files on optical disk (file format: .dwg, .dxf, .vsd, or compatible) with 11 inches x 17 inches prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Damper and valve schedules and data sheets may be submitted separately to improve product delivery dates. Provide submittals within 12 weeks after contract award, including the following:

1. BAS Hardware
   a. Complete bill of materials indicating quantity, manufacturer, model number, and other relevant technical data.
   b. Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation and maintenance instructions for items listed below and for other relevant items not listed below:
      1) DDC (controller) panels
      2) Transducers and transmitters
      3) Sensors (including accuracy data)
      4) Actuators
      5) Valves
      6) Dampers
      7) Relays and switches
      8) Control panels
      9) Power supplies
      10) Batteries
      11) User interface equipment
      12) Wiring
   c. Wiring diagrams and layouts for each control panel. Show all termination numbers.
   d. Floor plan schematic diagrams indicating field sensor, controller and power supply locations.

2. Network and User interface Hardware and Software
   a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
   b. Manufacturer's description and technical data, such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
      1) Central Processing Unit (CPU)
      2) Monitors
      3) Keyboards
      4) Power supply
      5) Battery backup
      6) Interface equipment between CPU and control panels
      7) Routers
      8) Repeaters
      9) Operating System software
      10) User interface software
      11) Color graphic software
      12) Third-party software
   c. Schematic diagrams of control, communication, and power wiring for central system installation. Label cables and ports with computer manufacturers’ model numbers and functions. Show all interface wiring to control system.
d. List of color graphics to be provided. Provide a conceptual layout of pictures and data for each graphic, showing or explaining which other graphics can be directly accessed.

3. Controlled Systems
   a. Riser diagrams showing control network layout, communication protocol, and wire types.
   b. Schematic diagram of each controlled system. Label control points/objects with point/object names. Graphically show all locations of control elements.
   c. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
   d. Instrumentation list for each controlled system. List each control system element in a table format. Show element name, type of device, manufacturer, model number, and product data sheet number.
   e. Mounting, wiring, and routing plan view drawing in 0.25 inch scale. Take into account HVAC, electrical and other systems’ design and elevation requirements. Show locations of concrete pads and bases and special wall bracing for panels to accommodate this work.
   f. Complete description of control system operation including sequences of operation. Include and reference a schematic diagram of system.
   g. Point/object list for each system controller including inputs and outputs (I/O), point/object numbers, controlled device associated with each I/O point/object, and location of I/O device. Indicate alarmed and trended points/objects.

4. Description of process, report formats, and checklists to be used in Part 3: “Control System Demonstration and Acceptance.”

5. LONWorks Protocol Implementation Conformance Statement (PICS) for each submitted type of LONWorks controller (B-BC, B-AAC, B-ASC) and user interface (B-OWS).

6. Instrumentation and Data Point Summary Table. Contractor shall submit in table format with the following information for each instrument and data point. The table is to be reviewed and approved by the owner’s representative prior to hardware and software installation and programming.
   a. Point name
   b. Point description: provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location
   c. Expected range (upper and lower limit)
   d. Instrumentation (as applicable): manufacturer, model number, range, and accuracy specification
   e. Type
      1) AI: analog input
      2) BI: binary input
      3) NAI: network analog input
      4) NBI: network binary input
      5) P: programmed (e.g., soft or virtual point in control sequence such as a PID input or output)
      6) C: calculated value; a soft or virtual point. If calculated value, provide logic diagrams or code and any constants used in formula. If time-based integrated values are required, provide time periods: minutes, daily, weekly, monthly, and yearly. Also indicate if it is a running average.
   f. Input resolution
   g. Graphic display resolution
   h. Data trend interval
   i. Number of samples stored in local controller before transfer to host computer/server database
   j. Data point address

C. Schedules

1. Provide a Schedule of work within one month of contract award indicating:
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1. Intended sequence of work items
2. Start date of each work item
3. Duration of each work item
4. Planned delivery dates for ordered material and equipment, and expected lead time
5. Milestones indicating possible restraints on work by other trades or situations

2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

D. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

1. Project Record Drawings.
   a. As-built versions of the submittal shop drawings provided as AutoCAD 2009 (or newer) compatible files on optical media and as 11 inches x 17 inches prints.
   b. Submittals to include complete electrical point-to-point wiring diagrams, component layouts, system and equipment component sequences of operation, start-up and checkout procedures. Include a list of all unit default safety and control settings, whether fixed or adjustable, as shipped from the factory. Where field modifications are required to meet the specification, provide all modification labor and materials, and submit a complete, detailed, step-by-step procedure for the modifications.

2. Testing and Commissioning Reports and Checklists. Completed versions checklists and trend logs used to meet requirements of Part 3: “Control System Demonstration and Acceptance.”

   a. As-built versions of the submittal product data.
   b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
   c. User’s manual with procedures for operating control systems: logging on and off, handling alarms, producing point/object reports, trending data, overriding computer control, and changing setpoints and variables.
   d. Programming manual or set of manuals with description of the programming language and syntax of statements for algorithms and calculations used of point/object database creation and modification, of program creation and modification, and editor use.
   e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points/objects, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
   f. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
   g. Graphic files, programs and database on magnetic or optical media.
   h. List of recommended spare parts with part numbers and suppliers.
   i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
   j. Complete original-issue copies of furnished software, including operating systems, custom programming language, user interface software, and graphics software.
   k. Licenses, guarantee, and warranty documents for equipment and systems.
   l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

4. Training Materials: Provide course outline and manuals for each class at least six weeks before the first class. Engineer will modify course outlines and manuals if necessary to meet Owner’s needs. Engineer will review and approve course outlines and manuals at least three weeks before first class.

1.9 Warranty
A. Warrant all work as follows:

1. Warrant labor and materials for specified BAS free from defects for a period of 12 months after final acceptance. BAS failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. Respond during Owner’s business hours within 24 hours of Owner’s warranty service request.

2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

3. If Engineer determines that equipment and systems operate satisfactorily at the end of the final start-up, testing, and commissioning phase, Engineer will certify in writing that BAS operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

4. Provide updates to user interface software, project-specific software, graphic software, database software, and firmware which resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above mentioned items. Do not install updates or upgrades without Owner’s written authorization.

5. Exception: Reused devices shall not be required to be warranted except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer’s acceptance.

1.10 Ownership Of Proprietary Material

A. Project specific software and documentation shall become Owner’s property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application programming code
5. Documentation

PART 2 - PRODUCTS

2.1 Materials

A. The equipment specified shall be provided as defined herein, shown on the drawings and as required to accomplish the sequences of control.

B. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner or Owner’s Representative. Spare parts shall be available for at least five-years after completion of this contract.

2.2 LONWorks Communications

A. Control products, communication media, connectors, repeaters, hubs and routers shall comprise a LONWorks BAS. Controllers and user interface communication shall conform to ANSI/ASHRAE Standard 135, LONWorks.

B. Each controller shall have a communication port for connections to an user interface.

C. Project drawings indicating remote buildings or sites to be connected to the Enterprise network shall allow for communication with each controller on the network as specified in Paragraph D.

D. Network user interface and value passing shall be transparent to network architecture.
1. A user interface connected to the BAS shall allow the user to interface with networked controllers as if directly connected. BAS information such as data, status, reports, system software, and custom programs, shall be viewable and editable from the user interface.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be available on the network. Program and test all cross-controller links required to execute specified BAS operation. An authorized user shall be able to manage, maintain, and access the BAS network of controllers.

E. Workstations, Building Control Panels and Controllers with real-time clocks shall use the LONWorks Time Synchronization service. System shall automatically synchronize system clock daily from an user designated device via the network. The system shall automatically adjust for daylight saving and standard time as applicable.

F. System shall be expandable to at least twice the required data points with additional controllers, associated devices, and wiring. Expansion shall not require user interface hardware additions or software revisions.

2.3 Embedded Controller/Web Server

A. Embedded Controller/Web Server(s) shall manage communications between the LONWorks Advanced Application Controllers (B-AAC) and LONWorks Application Specific Controllers (B-ASC) which are connected to its communications trunks, manage communications between itself and other Embedded Controller/Web Servers and with Enterprise Network Server that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.

2.4 Graphical User Interface

A. All Embedded Controller/Web Servers shall be accessed via a single connection to the Enterprise Network Server. In this configuration, each Embedded Controller/Web Server can be accessed from a PC using Thin-Client Remote Desktop Connection User Interface and/or a PC using Thin-Client Web Browser User Interface.

B. The Thin-Client Remote Desktop Connection User Interface shall use any of the current versions of Windows Server with Remote Desktop Services and shall allow the Enterprise Server to host multiple, simultaneous client sessions. Remote Desktop shall use Remote Desktop Services technology to allow a single session to run remotely. A user shall connect to a Remote Desktop Session Host (RD Session Host) server by using Remote Desktop Connection (RDC) client software. Thin-client hardware devices running an embedded Windows-based operating system shall run the RDC client software to connect to the RD Session Host Enterprise Server.

C. The Thin-Client Web Browser User Interface shall use any of the current versions of Microsoft Internet Explorer, Microsoft Edge, Mozilla Firefox, or Google Chrome browsers from any computer. The thin-client web browser shall be operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary user interface and configuration programs or browser plug-ins. Communication between the Thin-Client Web Browser User Interface and the Enterprise Network Server shall offer, at a minimum, encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

D. Software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to
the point of annunciation shall not exceed 5 seconds for network connected user
interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to
the point of annunciation shall not exceed 60 seconds for remote connected user
interfaces.

F. The user interface shall be completely interactive and shall provide a HTML5 experience that
supports the following features as a minimum:

1. Trending.
2. Scheduling.
3. Electrical demand limiting.
5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
8. Parameter change of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of users.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

G. Software Components: All software shall be the most current version. All software
components of the BAS software shall be provided and installed as part of this project. BAS
software components shall include:

2. 5 Year Software Maintenance Agreement. Labor to implement shall be included.
3. Embedded System Configuration Utilities for future modifications to the system and
controllers.
5. Embedded Direct Digital Control software.
6. Embedded Application Software.
7. Embedded Native Function-block programming software and all controller “Setup
Wizards”.

H. Login: On launching the user interface and selecting the appropriate domain name or IP
address, the user shall be presented with a login page that will require a login name and
strong password. Navigation in the system shall be dependent on the user's role-based
application control privileges.

I. Web Page Navigation: Using a collection of web pages, it shall be constructed to "feel" like a
single application, and provide a complete and intuitive mouse/menu driven user interface. It
shall be possible to navigate through the system using a web browser to accomplish
requirements of this specification. The GUI shall (as a minimum) provide for navigation, and
for display of animated graphics, schedules, alarms/events, live graphic programs, active
graphic set point controls, configuration menus for user access, reports and reporting actions
for events.

J. Tree Navigation: Navigation through the GUI shall be accomplished by clicking on the
appropriate level of a navigation tree (consisting of an expandable and collapsible tree control
like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics.
Both the navigation tree and action pane shall be displayed simultaneously, enabling the user
to select a specific system or equipment and view the corresponding graphic. The navigation
tree shall as a minimum provide the following views: Geographic, Network, Groups and
Configuration.
1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
2. Groups View shall display Scheduled Groups and custom reports.
3. Configuration View shall display all the configuration categories (Users, Schedule, Event, Reporting and Roles).

K. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:

1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web-browser. User shall have ability to save custom dashboards.
3. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
4. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the user to depress an 'accept/cancel' button.
5. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
6. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
7. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
8. Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
9. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

L. Color Graphics: The GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI user interface software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
   a. Each piece of equipment monitored or controlled including each terminal unit.
   b. Each building.
   c. Each floor and zone controlled.
M. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the GUI, a user (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further user intervention would be required and every control module in the system with would be automatically downloaded with the 'Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the LONWorks standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
   a. Types of schedule shall be Normal, Holiday or Override.
   b. A specific date.
   c. A range of dates.
   d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
   e. Wildcard (example, allow combinations like second Tuesday of every month).
2. Schedule Categories: The system shall allow users to define and edit scheduling categories (different types of “things” to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, users shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the user shall be able to define an 'individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the 'tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the 'tenant group'.
4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the user schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the user (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

N. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an 'Alarms' view. Alarms, and reporting actions shall have the following capabilities:

1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An user shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
2. Alarm Categories: The user shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the user to easily sort through multiple events displayed.
3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.

4. Alarm Areas: Alarm Areas enable an user to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an user to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.

5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.

6. Alarm Configuration: Users shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.

7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.

8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an user defined period.

9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Users shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
   a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
   b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
   c. File Write: The ASCII File write reporting action shall enable the user to append user defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the user. The user may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
   d. Write Property: The write property reporting action updates a property value in a hardware module.
   e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
   f. Run External Program: The Run External Program reporting action launches specified program in response to an event.

O. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

1. Viewing Trends: The user shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.

2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.

4. Dynamic Update. Trends shall be able to dynamically update at user-defined intervals.

5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ‘pan through’ historical data by simply scrolling the mouse.

6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.

7. Copy/Paste. The user shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

P. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archivable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the Enterprise Server hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.

Q. Custom Reports. Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

R. Tenant Override Reports. Provide a monthly report showing the daily total time in hours that each tenant has requested after-hours HVAC and lighting services. Provide an annual summary report that shows the override usage on a monthly basis.

S. ASHRAE Standard 147 Report: Provide a daily report that shows the operating condition of each chiller as required by ASHRAE Standard 147. At a minimum, this report shall include:

1. Chilled water (or other secondary coolant) inlet and outlet temperature
2. Chilled water (or other secondary coolant) flow
3. Chilled water (or other secondary coolant) inlet and outlet pressures
4. Evaporator refrigerant pressure and temperature
5. Condenser refrigerant pressure and liquid temperature
6. Condenser water inlet and outlet temperatures
7. Condenser water flow
8. Refrigerant levels
9. Oil pressure and temperature
10. Oil level
11. Compressor refrigerant discharge temperature
12. Compressor refrigerant suction temperature
13. Addition of refrigerant
14. Addition of oil
15. Vibration levels or observation that vibration is not excessive
16. Motor amperes per phase
17. Motor volts per phase
18. PPM refrigerant monitor level
19. Purge exhaust time or discharge count
20. Ambient temperature (dry-bulb and wetbulb)
21. Date and time logged

T. Building Metrics Reports
1. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each building meter.

2. Provide an annual (12-month) summary report showing the monthly electrical consumption and peak demand with time and date stamp for each meter.

3. Gas Meter Report: Provide a monthly report showing the daily natural gas consumption for each meter. Provide an annual (12-month) report that shows the monthly consumption for each meter.

4. Weather Data Report: Provide a monthly report showing the daily minimum, maximum, and average outdoor air temperature, as well as the number of heating and cooling degree-days for each day. Provide an annual (12-month) report showing the minimum, maximum, and average outdoor air temperature for the month, as well as the number of heating and cooling degree-days for the month.

5. Energy Calculations: Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., L/s [GPM]) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window average (e.g., rolling average). The algorithm shall be flexible to allow window intervals to be user specified (e.g., 15-minutes, 30-minutes, 60-minutes). Provide an algorithm that calculates a fixed-window average. A digital input signal shall define the start of the window period (e.g., signal from utility meter) to synchronize the fixed window average with that used by the utility.

6. Provide the following building performance metrics in dynamic graphical and tabular formats at the graphical user interface. Submit calculations to Engineer of all calculated variables for approval. Continuously monitor dynamic data measurements and calculated data variables and automatically archive data to real-time data storage at fifteen-minute intervals. Provide real-time data storage capacity for 18 months and off-line data storage capacity for 5 years. Every 12 months automatically transfer real-time data storage to off-line data storage.

   a. Temperature Summary
      1) Average Indoor Air Temperature (°F)
      2) Average Indoor Air Temperature Setpoint (°F)
      3) Lowest Indoor Air Temperature (°F)
      4) Lowest Indoor Air Temperature Setpoint (°F)
      5) Highest Indoor Air Temperature (°F)
      6) Highest Indoor Air Temperature Setpoint (°F)
      7) Current Outdoor Air Temperature (°F)
      8) Forecasted High Outdoor Air Temperature (°F)
      9) Forecasted Low Outdoor Air Temperature (°F)
     10) Forecasted Heating Degree Days
     11) Forecasted Cooling Degree Days
     12) 30-year Daily Average Heating Degree Days
     13) 30-year Daily Average Cooling Degree Days

   b. Electricity Summary
      1) Current Electricity Usage (kWh)
      2) Target Electricity Usage (kWh)
      3) Predicted Electricity Usage (kWh)
      4) Month to Date Electricity Usage (kWh)
      5) Year to Date Electricity Usage (kWh)
      6) Current Electricity Site Energy (kBtu)
      7) Target Electricity Site Energy (kBtu)
      8) Predicted Electricity Site Energy (kBtu)
      9) Month to Date Electricity Site Energy (kBtu)
     10) Year to Date Electricity Usage Site Energy (kBtu)
     11) Current Electricity Source Energy (kBtu)
     12) Target Electricity Source Energy (kBtu)
     13) Predicted Electricity Source Energy (kBtu)
     14) Month to Date Electricity Source Energy (kBtu)
     15) Year to Date Electricity Usage Source Energy (kBtu)

   c. Gas Summary
1) Current Gas Usage (therms)
2) Predicted Gas Usage (therms)
3) Month to Date Gas Usage (therms)
4) Year to Date Gas Usage (therms)
5) Current Gas Site Energy (kBtu)
6) Target Gas Site Energy (kBtu)
7) Predicted Gas Site Energy (kBtu)
8) Month to Date Gas Site Energy (kBtu)
9) Year to Date Gas Usage Site Energy (kBtu)
10) Current Gas Source Energy (kBtu)
11) Target Gas Source Energy (kBtu)
12) Predicted Gas Source Energy (kBtu)
13) Month to Date Gas Source Energy (kBtu)
14) Year to Date Gas Usage Source Energy (kBtu)

d. Energy Intensity Summary
1) Electricity Site Energy Intensity (kBtu/ft$^2$-yr)
2) Gas Site Energy Intensity (kBtu/ft$^2$-yr)
3) Electricity Source Energy Intensity (kBtu/ft$^2$-yr)
4) Gas Source Energy Intensity (kBtu/ft$^2$-yr)
5) Combined Total Energy Intensity (kBtu/ft$^2$-yr)
6) Target Combined Total Energy Intensity (kBtu/ft$^2$-yr)
7) Predicted Combined Total Energy Intensity (kBtu/ft$^2$-yr)
8) Energy Cost Intensity ($/ft^2$)

e. Green House Gas (GHG) Emission Summary
1) Current Direct GHG Emissions (MtCO$_2$e)
2) Current Indirect GHG Emissions (MtCO$_2$e)
3) Current Total GHG Emissions (MtCO$_2$e)
4) Target Total GHG Emissions (MtCO$_2$e)
5) Predicted Total GHG Emissions (MtCO$_2$e)

f. Water Summary
1) Indoor Water Use (kGal)
2) Indoor Water use per sq. ft. (kGal)
3) Outdoor Water Use (kGal)
4) Total Indoor and Outdoor Water Use (kGal)
5) Wastewater/Sewer Use (kGal)

U. Security Access: Systems that access from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:
1. Roles: Roles shall reflect the actual roles of different types of users. Each role shall comprise a set of ‘easily understood English language’ privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
   b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.

V. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same user defined HVAC Role) to different areas of the system.

W. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a
GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

X. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

Y. Graphic Sequence: The clarity of the graphic sequence shall be such that the user has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the user with an understandable and exact representation of each sequence of operation.

Z. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:

1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.

AA. Live Graphical Programs: The Graphic Programming software shall support a 'live' mode, where all input/output data, calculated data and set points shall be displayed in a 'live' real-time mode.

2.5 LONWorks Advanced Application Controller (B-AAC)

A. General. Provide an adequate number of LONWorks Advanced Application Controllers (B-AAC) to achieve the performance specified in the Part 1 Article on “System Performance”. B-AAC shall provide microprocessor based self-contained stand-alone fully programmable
operation of local process control loops. The controller platform shall provide options and advanced system functions, programmable and configurable, that allow standard and customizuable control solutions required in executing the “Sequence of Operation”. All local level application programs shall be installed on individual controllers in non-volatile memory. Control systems that utilize 'canned' programs or programmable read only memory (PROM) level application programming are not acceptable. Each of these panels shall meet the following requirements.

1. The B-AAC shall have sufficient memory to support its operating system, database, and programming requirements.
2. Data shall be shared between networked B-AACs.
3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
4. Controllers that perform scheduling shall have a real-time clock.
5. The B-AAC shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall
   a. Assume a predetermined failure mode,
   b. Generate an alarm notification.
6. The B-AAC shall communicate with other LONWorks devices on the network using protocol specific services.
7. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
8. Provide documentation for each device, with the following information:
   a. LONWorks Device; MAC address, name, type and instance number,
   b. LONWorks Objects; name, type and instance number.

B. Communication

1. Each B-AAC shall reside on a LONWorks network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
2. The controller shall provide a service communication port using LONWorks Data Link/Physical layer protocol for connection to a portable user’s terminal.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32 degrees F to 150 degrees F and 10 to 90 percent RH.
2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F.

D. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable user terminal.

E. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

F. Memory. The B-AAC shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

G. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.
2.6 LONWorks Application Specific Controller (B-ASC)

A. General. LONWorks Application Specific Controllers (B-ASCs) are microprocessor-based BAS controllers which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user-programmable, but are customized for operation within the confines of the equipment they are designed to serve. B-ASCs may not be used for complex sequences of operation. B-ASCs shall communicate with other LONWorks devices on the network using the Read (Execute) Property service as defined in Clause 15.5 of ASHRAE Standard 135. Each B-ASC shall be certified or listed for compliance to the LONWorks standards.

1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
2. Each B-ASC will contain sufficient I/O capacity to control the target system.
3. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
4. Provide documentation for each device, with the following information:
   a. LONWorks Device; MAC address, name, type and instance number,
   b. LONWorks Objects; name, type and instance number.

B. Communication

1. Each controller shall reside on a LONWorks network using the MS/TP or Ethernet Data Link/Physical layer protocol. Each network of controllers shall be connected to one building controller.
2. Each controller shall have a LONWorks Data Link/Physical layer compatible connection for a laptop computer or a portable user’s tool. This connection shall be extended to a space temperature sensor port where shown and allow access to the entire network.
3. Each controller shall have a secondary sub network for communicating sensors or I/O expansion modules.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32 degrees F to 150 degrees F and 10 to 90 percent RH.
2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.

F. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

G. Transformer. Power supply for the ASC must be rated at a minimum of 125 percent of ASC power consumption and shall be of the fused or current limiting type.

2.7 MODBUS System Integration
A. The BAS shall support the integration of device data from MODBUS RTU, ACSII, or TCP control system devices. The connection to the MODBUS system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

1. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the MODBUS system data into the FPMS. Objects provided shall include at a minimum:
   2. Read/Write MODBUS AI Registers
   3. Read/Write MODBUS AO Registers
   4. Read/Write MODBUS BI Registers
   5. Read/Write MODBUS BO Registers

B. All scheduling, alarming, logging and global supervisory control functions, of the MODBUS system devices, shall be performed by the Network Area Controller.

C. The BAS supplier shall provide a MODBUS system communications driver. The equipment system vendor that provided the equipment utilizing MODBUS shall provide documentation of the system’s MODBUS interface and shall provide factory support at no charge during system commissioning.

2.8 Input/Output Interface

A. Hardwired inputs and outputs may tie into the BAS through building, advanced application, or application specific controllers.

B. All input and output points shall be protected such that shorting of the point to itself, to another point, or to ground, shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 volts of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.

D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low-voltage (0-10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with – and field configurable to – commonly available sensing devices.

F. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and advanced application controllers shall have three-position (On/Off/Auto) override switches, and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC signal or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or advanced application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4 percent of range per year.

H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal
units, duct mounted heating coils, zone dampers, radiation, etc.) Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of user tracking.

I. Input/Output points shall be universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.

J. System Capacity. The system size shall be expandable to at least twice the number of input/output objects/points required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The user interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

K. Each controlled device or function shall be a separate output of the digital controller (i.e., Economizer, Heating Valve, Cooling Valve are three (3) separate output points). When a points’ list is provided the greater number of points and their configuration shall govern. Multiplexers or programmable logic controllers utilized with digital controller input and output points to expend the digital controller I/O capabilities will not be allowed.

PART 3 - EXECUTION

3.1 Pre-Installation Sequences of Operations Meeting

A. Prior to shop drawings submittals and any hardware installation, set-up and conduct a “Sequences of Operations” meeting to review the specified sequences to confirm an understanding of intent. Invited attendees shall include the BAS software programming technicians, Owner’s representative(s), Commissioning agent, Construction Manager, and Engineer of Record. Coordinate with Construction Manager.

3.2 Examination

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor’s work and the plans and the work of others, then report these discrepancies to the Engineer and obtain written instructions for any changes necessary to accommodate the temperature control work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect to report such discrepancies shall be made by and the costs borne by this Contractor.

3.3 Protection

A. Protect all work and material from damage by his work or employees, and shall be liable for all damage thus caused.

B. The installing contractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. Protect any material that is not immediately installed. Close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.4 Coordination
A. Site

1. Where the temperature control work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If temperature control work is installed before coordinating with other trades, so as to cause any interference with work of other trades, the temperature control work shall be re-worked to correct the condition without extra charge.

2. Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.

B. Test and Balance

1. Furnish all tools necessary to interface to the control system for test and balance purposes.

2. Provide training in the use of these tools. This training will be planned for a minimum of 4 hours.

3. In addition provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.

4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

C. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated as follows:

1. All communication media and equipment shall be provided as specified in Part 2: “Communication” of this specification.

2. Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.

3. Coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.

D. Revise equipment tagging and nomenclature, room numbering, etc. to reflect as-built conditions or an Owner’s preference for integration into his existing naming numbering convention.

3.5 Field Quality Control

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

B. Continually monitor the field installation for code compliance and quality of workmanship.

C. Have work inspected by authorities having jurisdiction over the work.

3.6 Controllers

A. Provide a separate controller for each AHU, terminal unit, fan coil, and other unitary equipment and HVAC systems. A DDC controller may control more than one system provided that all points/objects associated with the system are assigned to the same DDC controller. Points/objects used for control loop reset such as outside air or space temperature are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15 percent spare I/O point/object capacity for each point/object type found at each
location. If input /objects are not universal, 15 percent of each type is required. If outputs are not universal, 15 percent of each type is required. A minimum of one spare is required for each type of point/object used.

1. Future use of spare capacity shall require providing the field device, field wiring, point/object database definition, and custom software. No additional controller boards or point/object modules shall be required to implement use of these spare points.

3.7 Programming

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25 percent of available memory free for future use.

B. Point/object Naming: System point/object names shall be modular in design, allowing easy user interface without the use of a written point/object index. Use the following naming convention:

AAABBBCCDDDEEE where:

AAA is used to designate the location of the point/object within the building such as mechanical room, wing, or level, or the building itself in a multi-building environment.

BBB is used to designate the mechanical system with which the point/object is associated (e.g., A01, HTG, CLG, LTG).

CCC represents the equipment or material referenced (e.g., SAF for supply air fan, EXF for exhaust fan, RAF for return air fan).

D or DD or DDD may be used for clarification or for identification if more than one of CCC exists (e.g., SAF10, EXF121).

EE represents the action or state of the equipment or medium (e.g., T for temperature, RH for humidity, CO for control, S for status, D for damper control, I for current).

C. Software Programming

1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

a. Text-based:
   1) must provide actions for all possible situations
   2) must be modular and structured
   3) must be commented

b. Graphic-based
   1) must provide actions for all possible situations
   2) must be documented

c. Parameter-based
   1) must provide actions for all possible situations
   2) must be documented

2. After submittal and review of control software, offer to schedule a meeting with the Engineer and Commissioning Agent (CxA) to review system function.

D. Graphical User Interface

Show on each graphic all input and output points/objects for the system. Also show relevant calculated points/objects such as setpoints.

2. Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point/object show.

3. Provide all the labor necessary to install, initialize, start up, and troubleshoot all user interface software and their functions as described in this section. This includes any operating system software, the user interface database, and any third-party software installation and integration required for successful operation of the user interface.

4. Provide graphic representation of each system. Graphic shall have a link to its respective approved as-built sequence of operation in portable document format (pdf) or hypertext markup language format (html).

5. Provide graphic representation of each control device component (sensor, controller, controlled device). Each control device component graphic representation shall have a cursor-hover-over pull-down box with links to the manufacturer’s data sheet, installation instructions, maintenance instructions, and programming instructions literature in portable document format (pdf) or hypertext markup language format (html). Also, provide a link to an active trend of sensor and controlled device components.

6. Provide graphic representation of each equipment component (pump, boiler, chiller, air handling unit, etc.). Each equipment component shall have a cursor-hover-over pull-down box with links to the manufacturer’s data sheet, installation, maintenance, and programming literature in portable document format (pdf) or hypertext markup language format (html). For equipment components with factory mounted controllers provide an additional link to a graphic representation of all equipment controller data available via the respective communication protocol interface in tabular format.

7. The ATC Contractor shall initially prepare and be responsible for a Graphical User Interface Development Plan. The plan shall describe the process for the development of the GUI.

8. GUI Scope Meeting: Within 45 days from execution of the Contract, participate in a scope meeting with the GUI Development Team chaired by the ATC Contractor. The purpose of the meeting includes a review of the GUI Development Plan with discussions of development schedule, graphical requirements, and assignments of responsibilities.

9. GUI Coordination Meetings: The GUI Development Team members will meet on a predetermined and approved basis (by the Owner) to review progress on the GUI work, coordinate scheduling conflicts, and to discuss strategies and processes for upcoming tasks. The meetings will be chaired by the ATC Contractor. Allow for 80 hours of meeting time.

10. GUI Development Meeting Minutes: The ATC Contractor shall prepare minutes of the initial scope and progress meetings, and shall include a copy of the agenda, and identify location and date of the meeting, and individuals in attendance. Minutes shall be distributed to members of the GUI Development Team.

11. GUI Development Team: Members of the GUI Development Team shall include, but not be limited to the Owner, ATC Contractor, and such parties designated by the Owner or ATC Contractor.

3.8 Control System Checkout And Testing

A. Start-up Testing: All testing listed in this article shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner’s Representative is notified of the system demonstration.

1. Upon completion of the control system, adjust all components of the system. Make all adjustments in the control system required and as directed by the balancer to achieve the desired air balance quantities. All instruments shall be carefully calibrated and each control function shall be demonstrated to function properly, to the satisfaction of the Engineer and the Owner. Provide a complete instruction manual covering the function and operation of all components. At the time of demonstration, each function shall be simulated to ensure that controls respond properly to all signals, and the Owner shall be instructed in the proper operation of the system.
2. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

3. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

4. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers’ recommendations.

5. Verify that all binary output devices (relays, solenoid valves, two position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

6. Verify that all analog output devices (transducers, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Check all control valves and automatic dampers to ensure proper action and closure. Make any necessary adjustments to valve stem and damper blade travel.

7. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.

8. Alarms and Interlocks
   a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
   b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
   c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

9. Each unit and associated controls, safeties and wiring shall be checked out, started and adjusted by a factory trained service technician. Submit a startup report including a list of all unit safety and control settings, whether fixed or adjustable, as field checked and setup per the specified design conditions five days after unit startup. Submit service technician certification upon request.

3.9 Control System Demonstration And Acceptance

A. Demonstration

1. Prior to commissioning and acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the temperature controls have been completed, started up and performed its own tests.

2. The tests described in this section are to be performed in addition to the tests that are performed as a necessary part of the installation, startup, and debugging process and as specified in the “Control System Checkout and Testing” Article in Part 3 of this specification. The Engineer may be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.

3. The demonstration process shall follow that approved in Part 1: “Submittals.” The approved checklists and forms shall be completed for all systems as part of the demonstration.

4. Provide at least two persons equipped with two way communication, and demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point/object and system. Provide and operate any test equipment required to prove the proper operation.

5. Unless otherwise agreed to by the Cx Agent and the project engineer for specific points, trend log every point/object for one week continuous operation following demonstration period. Review report and correct any operational deficiencies and submit correction report and trend logs for record purposes. Also, submit to the Commissioning Agent for their review, prior to start of Commissioning.
As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.


Demonstrate compliance with Sequences of Operation through all modes of operation.

Demonstrate complete operation of User Interface.

Additionally, the following items shall be demonstrated:

a. DDC Loop Response. Supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in setpoint, which represents a change of actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Further tune any loop that yields unreasonably under-damped or over-damped control.

b. Optimum Start. Supply a trend data output showing the capability of the algorithm. The hour by hour trends shall include the output status of all optimally started equipment, as well as temperature sensor inputs of affected areas.

c. Interface to the building fire alarm system.

d. Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48 hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

Any tests that fail to demonstrate the operation of the system shall be repeated at a later date, and any necessary repairs or revisions to the hardware or software to successfully complete all tests shall be made.

B. Acceptance

1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: Submittals.

C. During the first year of operation, after acceptance by the Owner, provide complete service to adjust or assist the Owner in adjusting the equipment to obtain optimum performance from the control equipment and from the heating and air conditioning systems in general. This shall be done without additional expense to the Owner. This work shall include revisions to DDC software programs and controller, and all PC front end software upgrades. All software shall be provided to the Owner in disk form, including back-ups of final field programs.

3.10 Cleaning

A. Clean up all debris resulting from its activities daily. Remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.11 Training
A. Provide a minimum of three onsite training classes 8 hours in length during the construction period for personnel designated by the owner.

B. Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be 8 hrs. in length and must be coordinated with the building Owner.

C. Train the designated staff of Owner’s Representative and Owner to enable them to:

1. Day-to-day Users:
   a. Proficiently operate the system
   b. Understand control system architecture and configuration
   c. Understand DDC system components
   d. Understand system operation, including DDC system control and optimizing routines (algorithms)
   e. Operate the user interface and peripherals
   f. Log on and off the system
   g. Access graphics, point/object reports, and logs
   h. Adjust and change system setpoints, time schedules, and holiday schedules
   i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
   j. Understand system drawings, and Operation and Maintenance manual
   k. Understand the job layout and location of control components
   l. Access data from DDC controllers
   m. Operate portable user’s terminals

2. Advanced Users:
   a. Make and change graphics on the user interface
   b. Create, delete, and modify alarms, including annunciation and routing of these
   c. Create, delete, and modify point/object trend logs, and graph or print these
   d. Create, delete, and modify reports
   e. Add, remove, and modify system’s physical points/objects
   f. Create, modify, and delete programming
   g. Add panels when required
   h. Add user interface stations
   i. Create, delete, and modify system displays — both graphical and otherwise
   j. Perform BAS system field checkout procedures
   k. Perform DDC controller unit operation and maintenance procedures
   l. Perform user interface and peripheral operation and maintenance procedures
   m. Perform BAS system diagnostic procedures
   n. Configure hardware including PC boards, switches, communication, and I/O points/objects
   o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
   p. Adjust, calibrate, and replace system components

3. System Managers/Administrators:
   a. Maintain software and prepare backups
   b. Interface with job-specific, third-party user software
   c. Add new users and understand password security procedures

D. Provide course outline and materials as per “Submittals” Article in Part 1 of this specification. The instructor(s) shall provide one copy of training material per student.

E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

F. Classroom training shall be done using a network of working controllers representative of the installed hardware.

3.12 Outdoor temperature and humidity sensors shall be mounted on the north face of the building unless otherwise approved by the Engineer. Exact location shall be approved by the Architect.
3.13 In addition to the adjustments and fine tuning, include as a part of this contract the equivalent of five (5) man days of service technician and/or programming time for work as may be specified by the Engineer.

END OF SECTION
1.1 This section describes all sensors, controllers, instruments, valves, actuators, devices, for use with the control system specified in Section 23 09 23 Building Automation System (BAS) for HVAC. All control devices (valves, dampers, actuators, etc.) shall be included.

1.2 Refer to the HVAC Drawings, Section 23 09 23 Building Automation System (BAS) for HVAC, Section 23 09 93 Sequences of Operations, Section 23 09 95 BAS Points List, for sensor and device requirements.

1.3 All products used in the installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be available for at least 10 years after completion of this contract.

1.4 System shall conform to the following minimum standards over network connections:

   A. Reporting Accuracy. System shall report values with the minimum end-to-end accuracy listed in Table 1.

   B. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

### TABLE 1: Reporting Accuracy

<table>
<thead>
<tr>
<th>Measured Variable</th>
<th>Reported Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Temperature</td>
<td>±0.5°C [±1°F]</td>
</tr>
<tr>
<td>Ducted Air</td>
<td>±0.5°C [±1°F]</td>
</tr>
<tr>
<td>Outside Air</td>
<td>±1.0°C [±2°F]</td>
</tr>
<tr>
<td>Dewpoint</td>
<td>±1.5°C [±3°F] (-76 to 176°F scale)</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>±0.5°C [±1°F]</td>
</tr>
<tr>
<td>Delta-T</td>
<td>±0.15°C [±0.25°F]</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>±5% RH (0 – 90% scale)</td>
</tr>
<tr>
<td>Water Flow</td>
<td>±2% of full scale</td>
</tr>
<tr>
<td>Airflow (terminal)</td>
<td>±10% of full scale (see Note 1)</td>
</tr>
<tr>
<td>Airflow (measuring stations)</td>
<td>±5% of full scale</td>
</tr>
<tr>
<td>Airflow (pressurized space)</td>
<td>±3% of full scale</td>
</tr>
<tr>
<td>Air Pressure (ducts)</td>
<td>±25 Pa [±0.1” w.g.]</td>
</tr>
<tr>
<td>Air Pressure (space)</td>
<td>±3 Pa [±0.01” w.g.]</td>
</tr>
<tr>
<td>Water Pressure</td>
<td>±2% of full scale (see Note 2)</td>
</tr>
<tr>
<td>Electrical (A, V, W, Power factor)</td>
<td>±1% of reading (see Note 3)</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>±5% of reading</td>
</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>±50 ppm</td>
</tr>
</tbody>
</table>
Notes:
(1) Accuracy applies to 10 percent - 100 percent of scale.
(2) For both absolute and differential pressure.
(3) Not including utility supplied meters.

<table>
<thead>
<tr>
<th>Controlled Variable</th>
<th>Control Accuracy</th>
<th>Range of Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Pressure</td>
<td>±50 Pa [±0.2” w.g.]</td>
<td>0-1.5 kPa [0-6” w.g.]</td>
</tr>
<tr>
<td></td>
<td>±3 Pa [±0.01” w.g.]</td>
<td>-25 to 25 Pa [-0.1 to 0.1” w.g.]</td>
</tr>
<tr>
<td>Airflow</td>
<td>±10% of full scale</td>
<td></td>
</tr>
<tr>
<td>Space Temperature</td>
<td>±1.0ºC [±2.0ºF]</td>
<td></td>
</tr>
<tr>
<td>Duct Temperature</td>
<td>±1.5ºC [±3.0ºF]</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>±5% RH</td>
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</tr>
<tr>
<td>Fluid Pressure</td>
<td>±10 kPa [±1.5 psi]</td>
<td>0-1 MPa [1-150 psi]</td>
</tr>
<tr>
<td></td>
<td>±250 Pa [±1.0” w.g.]</td>
<td>0-12.5 kPa [0-50” w.g.]</td>
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<tr>
<td></td>
<td>Differential</td>
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<tr>
<td>Differential Enthalpy</td>
<td>±5 kJ/kg [±3 Btu/lb]</td>
<td>35 – 63 kJ/kg [20-36 Btu/lb]</td>
</tr>
</tbody>
</table>

PART 2 - PRODUCTS

2.1 Actuators And Operators

A. Electronic Actuators

1. Actuators shall include electronics to receive the digital controllers analog position signal and maintain the position through the use of positive position feedback. Torque of the actuator shall be the working pressures of the system for valves, the total static differential of an air system, plus 30 percent safety factors. Actuator shall be UL or other approved testing agency listed. Actuators shall be manufactured by Belimo Air Controls or approved equal.

2. Electronic actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

3. Unless noted otherwise as “floating point control”, mechanical fail safe shall incorporate a spring-return mechanism to return to the device to its “normal” position on loss of power. Electronic fail safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors with a visual indication of the fail safe status on the actuator face with the power fail position field adjustable between 0 to 100 percent in 10 degree increments, an adjustable 0 – 10 second operational delay, and capable of changing the fail-safe position through an integrated switch without removing the mounted actuator.

4. All rotary spring-return actuators shall be capable of both clockwise and counter-clockwise spring-return operation. Linear actuators shall spring-return to the retracted position.

5. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.

6. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not require more than 11 VA.

7. All actuators shall have an external manual gear release to allow manual positioning of the device when the actuator is not powered. Spring-return actuators with more than 7 N•m [60 in-lb] torque capacity shall have a manual crank for this purpose.
8. Actuators shall be provided with a raceway fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
9. Actuators shall be designed for a minimum of 60,000 full-stroke cycles at the actuator's rated torque.

2.2 Sensors And Transmitters

A. Any temperature or humidity sensing device mounted on an exterior wall shall be fitted with an insulated sub-base.

B. Binary Temperature Devices

1. Low-voltage space thermostats shall be 24 V, bimetal-operated type, concealed setpoint adjustment, 55 degrees F to 85 degrees F setpoint range, 2 degrees F maximum differential, and vented ABS plastic cover. Provide subbase with manual or automatic switching as required to perform the specified functions. Thermostats shall be single or multi-stage or modulating output as required to perform the functions specified.
2. Line-voltage space thermostats shall be bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, UL listed for electrical rating, concealed setpoint adjustment, 55 degrees F to 85 degrees F setpoint range, 2 degrees F maximum differential, and vented ABS plastic cover. Provide subbase with manual or automatic switching as required to perform the specified functions. Thermostats shall be single or multi-stage or modulating output as required to perform the functions specified.
3. Low-limit thermostats (freezestats). Low-limit airstream thermostats shall be UL listed, vapor pressure type or electronic type, with an element 20 ft. minimum length. Element shall cover the face of the coil at 1 ft. centers in a horizontal serpentine fashion and shall respond to the lowest temperature sensed by any 1 ft. section. When one freezestat cannot meet this requirement provide multiple freezestats. Unless noted otherwise, low-limit thermostats shall be manual reset type. For outdoor units and for indoor units where the freezestat controller is mounted more than 6 ft. above the floor, the low-limit thermostat shall be auto reset type with manual reset of its electrical circuit. Freezestats shall be supplied as DPST with one (1) set of normally closed contacts wired directly to fan circuit and one (1) set of normally open contacts to provide an alarm to the BAS.

C. Temperature Sensors

1. Temperature sensors shall be thermistors or Resistance Temperature Device (RTD), and be suitable for the application. Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary.
2. Precision thermistors may be used in applications below 200 degrees F. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degree F cumulative. A/D conversion resolution error shall be kept to 0.1 degree F. Total error for a thermistor circuit shall not exceed 0.5 degree F.
3. Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degree F cumulative. Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degree F.
4. Duct sensors shall be single point or averaging as shown or specified. Averaging sensors shall be a minimum of 5 feet in length per 10 sq. ft. of duct cross section. Mixed air and discharge air sensors shall be averaging type.
5. Space sensors shall be equipped with setpoint adjustment, occupancy mode override switch, display, and communication port. Thermostat cover shall be rectangular high impact ABS plastic (or equal) in a neutral cover.
6. Provide matched temperature sensors for differential temperature measurement.

D. Flow Switches
1. Flow-proving switches shall be either paddle or differential pressure type, as specified or as appropriate for the application.
2. Differential pressure type switches (air or water service) shall be UL Listed, SPDT snap acting, pilot duty rated (125 VA minimum), NEMA enclosure suitable for location, with scale range and differential suitable for intended application, or as specified.

E. Relays
1. Control relays shall be UL Listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200 percent (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA enclosure suitable for location when not installed in local control panel.

F. Current Transformers
1. AC current transformers shall be UL/CSA recognized and completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for ±1 percent accuracy at 5 A full scale output.
3. Transformers shall be split-core type for installation on new or existing wiring.

G. Voltage Transmitters
1. AC voltage transmitters shall be self-powered single loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
2. Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with ±1 percent full-scale accuracy with 500 ohm maximum burden.
3. Transmitters shall be UL/CSA recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.

H. Voltage Transformers
1. AC voltage transformers shall be UL/CSA recognized, 600 VAC rated, complete with built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4 to 55 degrees C [40 to 130 degrees F] and shall provide ±0.5 percent accuracy at 24 VAC and a 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic material.

I. Surge and Transient Protection
1. Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.
2. Power Line Surge Protection
   a. Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:
1) The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.
2) The device shall react within 5 nanoseconds and automatically reset.
3) The voltage protection threshold, line to neutral, shall be no more than 211 volts.
4) The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.
5) The primary suppression system components shall be pure silicon avalanche diodes.
6) The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.
7) The device shall have an indication light to indicate the protection components are functioning.
8) All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.
9) The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.
10) The device shall comply with IEEE C62.41, Class "B" requirements and be tested according to IEEE C62.45.
11) The device shall be capable of operating between -20 degrees F and +122 degrees F.

3. Telephone and Communication Line Surge Protection
   a. Provide surge and transient protection for DDC controllers and BAS network related devices connected to phone and network communication lines, in accordance with the following:
      1) The device shall provide continuous, non-interrupting protection, and shall automatically reset after safely eliminating transient surges.
      2) The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology.
      3) The device shall be installed at the distance recommended by its manufacturer.

4. Controller Input/Output Protection
   a. Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

J. Current Switches and Relays
   1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the BAS.
   2. Current relays for fan or pump proof shall be fully adjustable from 1.5 amps to 150 amps and shall have L.E.D. indicators. Form "A" (normally open) relays shall not be polarity sensitive. Current relays shall accommodate variable frequency drive outputs down to 6 HZ without contact chatter. Motor loads of less than 1.5 amps shall be multi-wound around current relay to increase "sensed" amperage to minimum setpoint for activation.

K. Pressure transducers
   1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
   2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.
   3. Air velocity pressure sensors shall use differential pressure to determine airflow rate and have repeatability within 1 percent of reading and an accuracy of ± 5 percent of range. The velocity range shall be from 0 to 3250 FPM.

L. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as shown.
M. Carbon Dioxide Sensors - Sensors shall be infrared type CO2 measuring device with a 4-20 ma linear output from 0 - 2000 ppm. Sensor shall be designed and provided with all necessary accessories for duct or space mounting, as shown on drawings. Sensors shall be manufactured by MSA or approved equal.

N. Local control panels

1. All indoor control cabinets shall be fully enclosed NEMA construction, suitable to the installed location, with [hinged door], key-lock latch, removable sub-panels. A single key shall be common to all field panels and sub-panels. Panels shall be unitized design for transducers, relays, gauges, etc.
2. Interconnections between internal and face-mounted devices pre-wired with color coded stranded conductors neatly installed in plastic troughs and/or tie wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power source to each local panel.
4. Provide 120V receptacle at each local panel location.

2.3 Control Valves

A. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown or specified herein or in 23 09 93.

B. All control valves shall be selected and rated for the duty imposed, sized per sizing criteria subparagraph, and in accordance with the manufacturer’s published literature.

C. Valves shall be equipped with a manual positioner to allow positioning of the valve in the absence of control power.

D. Ball Valves 2.0 inches and smaller, 0.01% percent leakage rate for port connected to coil, specifically designed for modulating hydronic service and ISO 9001 compliant:

1. Body
   a. ANSI B16.5 Class 150
   b. Cast bronze or brass
   c. Threaded (FNPT) or soldered connections
2. Bonnet
   a. Brass
   b. Packing: Reinforced Teflon or carbon filled Teflon and EPDM O-ring
3. Trim
   a. Stem: Stainless Steel
   b. Ball: Stainless Steel, equal percentage flow characteristic or modified equal percentage flow characteristic.
   c. Seat: Reinforced Teflon or carbon filled Teflon

E. Globe Valves 2.0 inches and smaller

1. Body
   a. ANSI B16.15 Class 125 and 250
   b. Cast bronze or brass
   c. Threaded (FNPT), union sweat, or flared connections
2. Bonnet
   a. Brass
   b. Packing: Self-adjusting Ethylene Propylene Rubber (EPR) ring pack u-cups, Spring loaded PTFE and Elastomer V-rings, or spring loaded Teflon cone
3. Brass Trim
a. Stem: Stainless Steel
b. Plug: Brass, equal percentage flow characteristic or modified equal percentage flow characteristic
c. Replaceable Seat: Brass against molded Elastomeric disc, or bronze

4. Stainless Steel Trim (Steam Applications)
a. Stem: Stainless steel
b. Plug: Stainless Steel, equal percentage flow characteristic or modified equal percentage flow characteristic
c. Replaceable Seat: Stainless Steel

F. Close-off Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

1. Water Valves:
   a. Two-way: 150 percent of total system (pump) head but not less than 30 psid.
   b. Three-way: 300 percent of pressure differential between ports A and B at design flow or 150 percent of total system (pump) head, whichever is greater.

G. Sizing Criteria

1. Water Valves:
   a. When selecting control valves for a specified Cv, the control valve supplier/manufacturer shall take into account the piping geometry effect on the Cv performance value, and include with the shop drawings.
   b. Control valves shall be selected to provide minimum .25 valve authority. Submit calculations for review.
   c. Two-position service: line size.
   d. Two-way modulating service: minimum .25 valve authority but maximum 10 ft.hd. w.p.d. unless otherwise noted on plans.
   e. Three-way Modulating Service: minimum .25 valve authority but maximum 10 ft.hd. w.p.d. unless otherwise noted on plans.

PART 3 - EXECUTION

3.1 Examination

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Examine the project drawings and specifications. If head room or space conditions appear inadequate, or if any discrepancies occur between the plans and the temperature controls work and the plans and the work of others, then report these discrepancies to the Engineer and obtain written instructions for any changes necessary to accommodate the temperature controls work with the work of others. Any changes in the work made necessary by the failure or neglect to report such discrepancies shall be made by and costs borne by this Contractor.

3.2 Installation Of Sensors

A. Install all sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Mixed air temperature sensors shall be located a minimum of 12 inches in front of 1st downstream coil (to prevent false reading of M.A.T.).

F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across face area. Each bend shall be supported with a capillary clip.

G. Low limit thermostats (freezestats) shall be installed in a serpentine manner horizontally across the coil face at 1 ft. centers. Each bend shall be supported with a capillary clip. Provide minimum 1 ft. of sensing element for each 1 ft. of coil area. Freezestat controller shall be located outside of airstream and installed in strict accordance with manufacturer’s instructions. For freezestats with auto-reset (refer to para 2.2-B.3 or control sequences), provide indoor NEMA 1 panel to house latching control relay, with reset button and light on face of panel. The latching relay shall have separate contacts for latching circuit (N.O.), AHU / fan safety circuits (N.C.) and DDC alarm input (N.O.). The circuit shall be arranged to automatically reset after power failure. For outdoor units, mount panel in mechanical room. For indoor units, mount panel on or near associated AHU.

H. Differential Air Static Pressure

1. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable), or to the location of the duct high-pressure tap and leave open to the plenum.

2. Return Duct Static Pressure: Pipe the low-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor.

3. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover at the specified location.

4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.3 Flow Switch Installation

A. Use correct paddle for pipe diameter.

B. Adjust flow switch in accordance with manufacturer’s instructions.

3.4 Control Valves

A. Control valves shall be installed in strict accordance with the valve manufacturer’s instructions and recommendations.

B. Steam valves shall have their stems and actuators horizontal or 45 degrees upright to promote cooling of the assembly.
3.5 Actuators

A. Mount and link control damper actuators per manufacturer’s instructions.

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.
4. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degrees available for tightening the damper seals. Actuators shall be mounted following manufacturer’s recommendations.
5. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer’s recommendations.

3.6 Local Control Panels

A. Local control panels shall be provided for the equipment being controlled. Panel shall be mounted in mechanical, electrical rooms or electrical closets. Mount panels on wall, columns or independent supports near each respective unit. Do not mount on the unit proper unless the unit has internal jam isolation and the control panel and unit have been designed for direct mounting.

3.7 Identification Of Hardware And Wiring

A. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2 inches of termination with the DDC address or termination number.
B. Permanently label or code each point/object of field terminal strips to show the instrument or item served.
C. Identify control panels with minimum 0.50 inch letters on laminated plastic nameplates.
D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
E. Identify room sensors relating to terminal box or valves with nameplates.
F. Manufacturers’ nameplates.
G. Identifiers shall match record documents.
H. Upon completion of the project, furnish a complete set of these drawings and diagrams, framed under clear plastic, and hang on the wall of the Mechanical Equipment Room where directed.

END OF SECTION
PART 1 - GENERAL

1.1 Provide all electrical wiring, both line voltage and low voltage, which is required to perform the automatic control functions.

1.2 Where power sources are required beyond sources explicitly shown on the Division 26 drawings, these shall be provided under the Division 23 Contract. Where auxiliary contacts are required on starters to perform the required functions these, too, shall be provided under the Division 23 Contract. Where not provided under Division 26, auxiliary external relays may be provided in lieu of auxiliary contacts.

1.3 Wiring, both line and low voltage, shall comply with The National Electric Code (NEC) and shall be subject to approval of the local code enforcing authorities.

1.4 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

1.5 Install all equipment in readily accessible locations as defined by the National Electrical Code (NEC).

1.6 Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

1.7 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

1.8 Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.

1.9 All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 5 cm [2 inches] of termination with the DDC address or termination number.

1.10 Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible. Where communication wire must cross high power wire (deemed as 110VAC or greater) it must do so at right angles.

1.11 All shields shall be grounded (earth ground) at one point only to eliminate ground loops. All shield grounding shall be done at the controller location with the shield at the sensor/device end of the applicable wire being left long and “safed” off in an appropriate manner.

1.12 There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted pairs (24awg) in accordance with the manufacturer’s wiring practices.

PART 2 - PRODUCTS

2.1 Wire, conduit and installation methods shall conform to applicable provisions of Division 26 - Electrical except that wiring smaller than No. 12 and conduit smaller than 0.75 inch are permitted as appropriate for the application.

2.2 Communication wire shall meet the following requirements as a minimum. Control system manufacturers recommendations which exceed these requirements shall govern.
A. Category 6 plenum rated, 4 twisted pair, non-shielded (UTP) station cable (capable of transmission speeds up to 100 Mb/s) shall be used for control system networking. Cable shall be insulated with FEP material and sequentially marked at 2 foot intervals. Color as selected by Owner.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>Standards/Certification</td>
<td>UL 444, UL 13</td>
</tr>
<tr>
<td></td>
<td>EIA/TIA 568, Cat. 5</td>
</tr>
<tr>
<td></td>
<td>PN-2841</td>
</tr>
<tr>
<td>DC Resistance</td>
<td>9.38 ohm/100 m</td>
</tr>
<tr>
<td>Maximum mutual capacitance at 1 KHz</td>
<td>5.6 nF/100 m</td>
</tr>
<tr>
<td>Unbalanced Capacitance at 1 KHz</td>
<td>330 pF/100 m</td>
</tr>
<tr>
<td>Impedance</td>
<td>100 ohm ± 15%</td>
</tr>
<tr>
<td>Structured Return Loss at 100 Mhz</td>
<td>23/16 dB/100 m</td>
</tr>
<tr>
<td>Attenuation (max at 100 m)</td>
<td>4.1 dB @ 4 Mhz</td>
</tr>
<tr>
<td></td>
<td>8.2 dB @ 16 Mhz</td>
</tr>
<tr>
<td></td>
<td>22.0 dB @ 100 Mhz</td>
</tr>
<tr>
<td>NEXT (min. at 100 m)</td>
<td>53.0 dB @ 4 Mhz</td>
</tr>
<tr>
<td></td>
<td>44.0 dB @ 16 Mhz</td>
</tr>
<tr>
<td></td>
<td>32.0 dB @ 100 Mhz</td>
</tr>
<tr>
<td>Propagation Delay (min. @ 10 Mhz)</td>
<td>5.7 ns/m</td>
</tr>
</tbody>
</table>

2.3 Wiring and raceways

A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.

B. All insulated wire to be copper conductors, UL labeled for 90 degrees C minimum service.

C. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

D. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

E. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

F. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

G. Sensor and/or signal cabling for controller I/O shall be multi-conductor type, stranded copper conductors, shielded, with plenum rated outer jacket. Conductor size shall be as recommended by the manufacturer for cable length and device power consumption.

PART 3 - EXECUTION

3.1 All line voltage wiring and low voltage wiring (except as stated below) shall be run in conduit. Low voltage wiring concealed above accessible ceilings may be run without conduit. Open wiring dropping into walls shall be run in conduit. Thermostats shall be installed on a single gang box and conduit shall be installed to extend into the plenum. Open wiring shall be bundled and supported at 3 ft. maximum intervals with a system of J-hooks. Cable trays installed by other trades may only
be used when approved by Owner and Technology Installer. Open wiring in air plenums shall be rated for such use and so labeled.

3.2 Thermostats and other wall mounted sensors shall be installed on a single gang box. EMT conduit shall be installed from the wall box to the plenum; cabling within the wall shall be in conduit.

3.3 Provide electrical circuits from the nearest appropriate “Legally Required” or “Owner Optional” emergency electrical panel to serve control panels, transformers, and other control equipment and devices. Circuits serving control panels and transformers for low voltage service shall be independent and used for no other purpose. Circuits for VAV DDC controllers and other unitary type controls need not be on “Legally Required” nor “Owner Optional” emergency power. Provide circuit wiring from the electrical panel. These circuits shall be clearly identified at the panels. Coordinate with Division 26.

3.4 When utilizing an Owner’s network for communication, provide network cable and pathways from each control panel to tech closets (or from panel to panel as required by system architecture) to ensure a complete and operational system. In addition, provide independent temporary means of communication (this may include but is not limited to all routers, switches, modems and temporary means of internet communication) as needed to ensure system can be fully tested, commissioned, used as temporary heating/cooling and balanced without reliance on the Owner’s or other trade systems being operational, as dictated by the construction schedule. Once permanent systems are completed by other trades, coordinate and assist in transference of communication pathways to permanent systems. Network cable and pathway shall comply with Division 27 specification requirements.

END OF SECTION
PART 1 - GENERAL

1.1 Implemented Sequences of Operation shall be in compliance with ASHRAE 90.1-2013, unless deviated by the sequences with-in. Any additional deviations must be reviewed with the Engineer prior to implementation.

1.2 Provide all equipment (valves, dampers, actuators, controllers, etc.) required to perform the functions specified unless noted herein or elsewhere in these contract documents. Electric motor driven equipment (pumps, chillers, compressors, cooling towers, etc.) shall be provided with minimum on (run) and minimum off timers to prevent short cycling of the equipment (coordinate with equipment manufacturer's).

1.3 All DDC system control points shall have a default value in case of sensor failure or logic error. All controlled devices shall fail safe on loss of control. All setpoints and parameters shall be fully adjustable from the end user / owner interface.

1.4 Refer to Section 23 09 23 for Sequences of Operations meeting.

PART 2 - PRODUCTS

2.1 Refer to Section 23 09 23 and 23 09 25 for applicable products.

PART 3 - EXECUTION

3.1 “Occupied”, “Unoccupied” and Override Modes

A. Each air-side system shall be scheduled (independently) for “Occupied” and “Unoccupied” modes of operation, unless stated otherwise in the specific system sequences of operations with-in.

B. Automatic controls shall be capable of retaining programming and time settings during loss of power for a period of at least ten hours, and shall include an accessible override that allows temporary operation of each system for up to two hours.

C. Automatic controls shall include a manually operated timer for each system capable of being adjusted to operate the systems for up to two hours.

D. The “Occupied” mode of operation shall be scheduled through a time and date calendar function at the DDC system operator workstation / 7-day programmable thermostat. The initial “Occupied” mode schedule shall be in effect Monday through Friday, 7:00 a.m. to 5:00 p.m. unless noted otherwise in the specific system sequences with-in. Coordinate time of day scheduling with Owner. Scheduling software shall be capable of seven different day-types per week.

E. The “Unoccupied” mode shall be in effect whenever the zone or system is not in “Occupied” mode. Activation of the building security system shall also override the zone or system to the “Unoccupied” mode.

F. “Override” mode shall put the zone or system into “Occupied” mode when any of the following occurs:

1. “Occupied” mode initiated through manual override of the “Unoccupied” mode at the operator workstation / programmable thermostat.
2. “Occupied” mode initiated by a zone override device. A zone override device shall be a manually operated switch, occupancy sensor, or vacancy sensor as defined with-in or on the drawings.
Whenever the zone or system occupancy sensor detects movement and heat changes, the “Occupied” mode shall be enabled. If movement and heat changes are not detected for 20 minutes (adjustable), the zone or system “Occupied” mode shall be disabled.

Whenever the zone vacancy sensor detects movement and heat changes, and the zone light switch is turned on, the “Occupied” mode shall be enabled. If movement and heat changes are not detected for 30 minutes (adjustable), or the zone light switch is turned off, the zone “Occupied” mode shall be disabled.

3.2 Adaptive Optimal Start Mode

A. For each air-side system, the DDC System shall utilize space temperature, outdoor air temperature, applicable “Occupied” heating and cooling setpoints and occupancy schedule to continuously adapt itself using a "learning" process to calculate the most optimal start time, up to 4 hours (adjustable) prior to scheduled occupancy time, to allow the average building space temperature to reach the “Occupied” space temperature setpoint determined by the heating or cooling mode. Programs which require manual fine-tuning of each fan system’s algorithms shall not be acceptable.

3.3 Zone Heating and Cooling Setpoints

A. Zone heating and cooling setpoints shall be as follows except as specified otherwise. All setpoints shall be adjustable.

“Occupied” Zone Cooling Setpoint: 75 deg F / As Defined on the drawings

“Occupied” Zone Heating Setpoint: 5 deg F below “Occupied” Zone Cooling Setpoint

“Unoccupied” Zone Cooling Setpoint: 7 deg F above “Occupied” Zone Cooling Setpoint but no warmer than 82 deg F

“Unoccupied” Zone Heating Setpoint: 10 deg F below “Occupied” Zone Heating Setpoint but no lower than 60 deg F. For radiant systems, the “Unoccupied” Zone Heating Setpoint shall be 4 degrees below the “Occupied” Zone Heating Setpoint.

3.4 Hot Water Unit Heaters

A. System Description:

1. Hot water cabinet unit heaters are being installed to provide supplemental heating. Refer to drawings.

B. Run Conditions:

1. Each unit heater seasonal isolation valve shall be closed whenever the outside air temperature is above 55 deg F.

C. Space temperature Control

1. Each heater shall be furnished with a line-size 2-position seasonal auto isolation valve.

3.5 VAV Boxes (Air Terminal Units)

A. The VAV box manufacturer shall provide the box with velocity sensor and air flow taps for use in the temperature controls. Provide all other control components. Send to the box manufacturer the DDC controller and damper actuator for factory mounting. Reheat boxes shall be provided with a 2-way / 3-way modulating hot water valve as indicated on the drawings. Also refer to drawings for listed cfm set points / and listed discharge air temperature set points as described below. Provide Auto Zeroing function to adjust the zero calibration point of the
pressure or velocity transducer VAV box control sequences shall be active when the associated AHU supply fan is "on".

B. VAV Shutoff (cooling-only) Control - If the space temperature is below setpoint, the box damper shall be at the listed Dead Band Minimum CFM. If space temperature rises above the cooling setpoint, the control shall modulate the box damper between the listed Dead Band Minimum CFM and the listed Cooling Maximum CFM to satisfy the space cooling setpoint. Box controls shall reverse action during "warm-up" cycles.

C. VAV Hot Water Reheat and Heating Control

1. Reheat Mode -- If mechanical cooling / chilled water valve is active or if economizer is active (outside air damper open beyond minimum setting), the following sequence shall be implemented:
   If the space temperature is in the dead band between heating and cooling set points, the box damper shall be positioned to the listed Dead Band Minimum CFM. (Note: Unless noted otherwise on the drawings Dead Band Minimum CFM shall be set to the scheduled value even if below manufacturer's minimum box CFM.) If space temperature rises above the cooling setpoint, the control shall modulate the box damper between the listed Dead Band Minimum CFM and the listed Cooling Maximum CFM to satisfy the space cooling setpoint. When the room temperature is below setpoint, the box damper and hot water valve shall be sequenced to maintain the space heating set point as follows:
   a. 1st stage of heating shall be to position the box damper at its listed Dead Band Minimum CFM and modulate the hot water valve to maintain space temperature, with a high limit discharge air temperature of 20 degrees above the space heating set point (except during warm-up cycles).
   b. If after 10 minutes the space heating set point cannot be maintained for 5 minutes, 2nd stage of heating shall be to modulate the box damper from the listed Dead Band Minimum CFM to the listed Reheat Maximum CFM while maintaining a discharge air temperature of 20 degrees above the space heating set point.
   c. Reverse the sequence when space heating setpoint is reached. When in a "warm up" cycle, the box damper shall go to the listed Heating Maximum CFM and the hot water valve shall be modulated to maintain the space heating set point (and supply air temperature not limited to 20 degrees above room set point).
   d. If hot water is not available the boxes shall act as Shutoff (cooling only) boxes.

2. Heating Mode -- If the outdoor air temperature is below 50 deg F and mechanical cooling / chilled water valve is not active and economizer is not active (outside air damper being controlled to minimum cfm), the following sequence shall be implemented:
   If the space temperature is in the dead band between heating and cooling set points, the box damper shall be positioned to the listed Dead Band Minimum CFM. If space temperature rises above the cooling setpoint, the control shall modulate the box damper between the listed Dead Band Minimum CFM and the listed Cooling Maximum CFM to satisfy the space cooling setpoint. When the room temperature is below setpoint, the box damper and hot water valve shall be sequenced to maintain the space heating set point as follows:
   a. 1st stage of heating shall be to position the box damper at its listed Dead Band Minimum CFM and modulate the hot water valve to maintain space temperature, with a high limit discharge air temperature of 95 deg F (except during warm-up cycles).
   b. If after 10 minutes the space heating set point cannot be maintained for 5 minutes, 2nd stage of heating shall be to modulate the box damper from the listed Dead Band Minimum CFM to the listed Heating Maximum CFM while maintaining a discharge air temperature of 95 deg F.
   c. Reverse the sequence when space heating setpoint is reached. When in a "warm up" cycle, the box damper shall go to the listed Heating Maximum CFM and the hot water valve shall be modulated to maintain the space heating set point (and supply air temperature not limited to 95 deg F).
   d. If hot water is not available the boxes shall act as Shutoff (cooling only) boxes.
D. Carbon Dioxide (CO$_2$) Over-Ride – Provide a wall-mounted CO$_2$ sensor for each high occupancy space as noted on the drawings. If measured CO$_2$ level rises above a high limit of 700 ppm (adjustable) for 5 minutes, increase the associated box supply air flow set point by 10 percent. For every 5 minutes the CO$_2$ level is above the high limit, increase box supply air flow set point an additional 10 percent. Do not exceed the listed Cooling Maximum CFM. Once the measured CO$_2$ level is below 600 ppm for 10 minutes, cancel the over-ride sequence. If a space CO$_2$ level rises above 1200 ppm an alarm shall be issued thru the BAS system.

E. Energy Management - Each VAV box shall have its own time of day schedule for “Occupied” and “Unoccupied” control. An override pushbutton shall be provided at each sensor thermostat to override the “Unoccupied” schedule for a fixed (programmable) time. The DDC system shall track, log and report on the amount of time each box was overridden as well as VAV box discharge air temperature.

3.6 Rooftop Unit RTU-1

A. System Description

1. The rooftop unit is a gas-fired DX packaged rooftop unit. Unit will be equipped with LONWorks compatible controls.
2. Refer to Rooftop Unit specifications for required control sequences. Coordinate with equipment supplier for required control accessories and control points.

B. Rooftop unit controls are to be integrated into the existing BAS control network

3.7 General Exhaust Fans

Each exhaust fan (and its respective automatic damper) where indicated on the Electric Drawing Starter Schedule shall be a separate start/stop point of the digital control system.

3.8 Monitoring and Alarms

The following points shall be monitored and alarmed at the monitoring console and as otherwise specified hereinafter:

A. Point Descriptions:

1. Current Sensing Relays Provide for all air handling unit supply and return/exhaust fans; all general exhaust fans.
2. High/Low Temperature Alarms on all DDCS temperature sensors with off normal messages.
3. Fire Alarm System Inputs Fire alarm shall be input into the DDCS for information and smoke control mode. Provide wiring from the DDCS inputs to the Fire Alarm System outputs. Coordinate connection points with the Electrical Contractor.

B. When interfacing with equipment providing remote analog inputs or receiving analog outputs to the DDCS or when monitoring requires the installation of external relays at the equipment being monitored, coordinate all requirements such as range, signal condition, grounding, wiring and input impedance with the supplier of the equipment being monitored.

C. Dial Out Alarms – DDCS shall initiate a phone call and print an alarm message at a remote printer, digital pager, or PC operating in terminal mode whenever the system detects a critical alarm. These alarms shall include but not be limited to: AHU freezesat alarm, chiller trouble, boiler or heating failure.

END OF SECTION
PART 1 - GENERAL

1.1 The following list and those shown on the drawings shall be the minimum points required of the Direct Digital Control System (DDCS). It is not the intent to show all required points. If or when additional points are required to accomplish the sequences of control specified, these points shall also be provided. The point types are identified as follows:

- DI  Contact Input (NO or NC)
- DO  Contact Output (NO or NC)
- AI  Analog Input
- AO  Analog Output
- PI  Pulsed Input

1.2 Boiler System Points List:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Common Return Water Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Common Supply Water Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Leaving Boiler Water Temperature</td>
<td>2</td>
</tr>
<tr>
<td>DO</td>
<td>Boiler Run Enable (On/Off)</td>
<td>2</td>
</tr>
<tr>
<td>DO</td>
<td>Hot Water Pump Start/Stop</td>
<td>2</td>
</tr>
<tr>
<td>DI</td>
<td>Hot Water Pump Flow Proof</td>
<td>2</td>
</tr>
<tr>
<td>DI</td>
<td>Boiler Flame Failure Trouble</td>
<td>2</td>
</tr>
<tr>
<td>DI</td>
<td>Boiler Emergency Shut-Off Tripped</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Boiler Burner Modulation</td>
<td>2</td>
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1.3 Chilled Water System Points List:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Common Return Water Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Common Supply Water Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Leaving Chilled Water Temperature</td>
<td>2</td>
</tr>
<tr>
<td>DO</td>
<td>Chiller Run Enable (On/Off)</td>
<td>2</td>
</tr>
<tr>
<td>DO</td>
<td>Chilled Water Pump Enable</td>
<td>2</td>
</tr>
<tr>
<td>DI</td>
<td>Chiller Alarm Trouble</td>
<td>2</td>
</tr>
<tr>
<td>DI</td>
<td>Chilled Water Pump Flow Proof</td>
<td>2</td>
</tr>
<tr>
<td>DO</td>
<td>Cooling Tower #1 Hi Lo Speed Control</td>
<td>2</td>
</tr>
<tr>
<td>DO</td>
<td>Cooling Tower #2 Hi Lo Speed Control</td>
<td>2</td>
</tr>
<tr>
<td>AI</td>
<td>Cooling Tower Basin Temperature</td>
<td>2</td>
</tr>
<tr>
<td>DI</td>
<td>Condenser Water Pump Flow Proof</td>
<td>2</td>
</tr>
<tr>
<td>AI</td>
<td>Condenser Water Supply Temperature Each Chiller</td>
<td>2</td>
</tr>
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1.4 Air Handling Unit Points List:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Return Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Mixed Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Supply Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Supply Air Static Pressure</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Leaving H.W. Coil Temperature</td>
<td>1</td>
</tr>
<tr>
<td>DI</td>
<td>Supply Fan Status</td>
<td>1</td>
</tr>
<tr>
<td>DI</td>
<td>Return Fan Status</td>
<td>1</td>
</tr>
</tbody>
</table>
AO Economizer Dampers 1
AO Heating Coil Valve 1
AO Cooling Coil Valve 1
AO Supply Fan Volume Control 1
AO Return Fan Volume Control 1
AI Air Filter Pressure Drop 1
DI Freezestat 1
DO Fan System Start/Stop 1
AI Space Temperature *
AI Return Air Humidity 1
AO Humidifier Control 1
AO Humidifier 2 Pos. Valve 1
DI Smoke Alarm **
DO Smoke Damper Closures 1
DI Smoke Damper End Switches ***

*One sensor for unoccupied control, additional space sensor as shown on drawings. When DDC zone control is specified all zone thermostats shall be DDC inputs.

**For notice of smoke detection at the B.A.S. (in addition to hardwired starter interlock for unit shutdown) and smoke damper control.

***One for each smoke damper.

1.5 Heat Recovery Air Handling Unit ______

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Outside Air Flow</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Return Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Return Air Humidity</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Entering Heat Wheel Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Mixed Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Supply Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Exhaust Air (Leaving ERW) Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Supply Duct Static Pressure</td>
<td>1</td>
</tr>
<tr>
<td>DI</td>
<td>Supply Fan Status</td>
<td>1</td>
</tr>
<tr>
<td>DI</td>
<td>Exhaust Fan Status</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Outside Air Damper</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Return Air Damper</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Hot Water Coil Return Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Exhaust Bypass Damper</td>
<td>1</td>
</tr>
<tr>
<td>DO</td>
<td>Outside Air Bypass Damper</td>
<td>1</td>
</tr>
<tr>
<td>DO</td>
<td>Energy Recovery Wheel S/S</td>
<td>1</td>
</tr>
<tr>
<td>DO</td>
<td>Supply Fan S/S</td>
<td>1</td>
</tr>
<tr>
<td>DO</td>
<td>Exhaust Fan S/S</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Heating Coil Valve</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Cooling Coil Valve</td>
<td>1</td>
</tr>
<tr>
<td>DO</td>
<td>Heating Coil Pump S/S</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Supply Fan Volume Control</td>
<td>1</td>
</tr>
<tr>
<td>DI</td>
<td>Air Filter Pressure Drop</td>
<td>3</td>
</tr>
<tr>
<td>DI</td>
<td>Freezestat</td>
<td>1</td>
</tr>
<tr>
<td>DO</td>
<td>Electric Preheat Coil</td>
<td>****</td>
</tr>
<tr>
<td>AI</td>
<td>Space Temperature</td>
<td>*</td>
</tr>
<tr>
<td>AO</td>
<td>Exhaust Fan Volume Control</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Exhaust Air Flow</td>
<td>1</td>
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<tr>
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<td>Energy Recovery Wheel Status</td>
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<td>DI</td>
<td>Smoke Alarm</td>
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<tr>
<td>DO</td>
<td>Smoke Damper Closures</td>
<td>1</td>
</tr>
<tr>
<td>DI</td>
<td>Smoke Damper End Switches</td>
<td>***</td>
</tr>
</tbody>
</table>
*Monitor DDC Zone Sensors.
**For notice of smoke detection at the B.A.S. (in addition to hardwired starter interlock for unit shutdown) and smoke damper control.
***One for each smoke damper.
****See AHU Schedule for number of steps

1.6 VAV Unit Ventilator Points List:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Space Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Space Setpoint</td>
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<tr>
<td>AI</td>
<td>Discharge Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Return CO2</td>
<td>1</td>
</tr>
<tr>
<td>DI</td>
<td>Freezestat</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Outside/Return Air Damper</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Cooling Coil Valve</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Heating Coil Valve</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Face &amp; Bypass Damper</td>
<td>1</td>
</tr>
<tr>
<td>AO</td>
<td>Supply Fan Speed</td>
<td>1</td>
</tr>
<tr>
<td>DO</td>
<td>Relief Damper</td>
<td>1</td>
</tr>
</tbody>
</table>

1.7 VAV Air Terminal Unit Points List (per each unit):

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Space Temperature</td>
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</tr>
<tr>
<td>AI</td>
<td>Space Temperature Setpoint</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Discharge Air Temperature</td>
<td>1</td>
</tr>
<tr>
<td>AI</td>
<td>Air Volume (CFM)</td>
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</tr>
<tr>
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<td>Occupancy Override</td>
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<td>Air Damper</td>
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<tr>
<td>AO</td>
<td>Reheat Coil Valve</td>
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1.8 Exhaust Fan Systems

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<tr>
<td>DO</td>
<td>Exhaust Fan Smoke Damper Closures</td>
<td>*</td>
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<tr>
<td>DI</td>
<td>Exhaust Fan Status</td>
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<tr>
<td>DI</td>
<td>Smoke Damper End Switches</td>
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*One for each fan system.
**For notice of smoke detection at the B.A.S., shutdown of fan, and closure of associated smoke dampers.
***One for each smoke damper.

1.9 General or Global Points:

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<td>PI</td>
<td>Building Electric Meter</td>
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23 21 13  HYDRONIC PIPING

PART 1 - GENERAL

1.1 Hydronic piping systems (hot water) shall be as shown on the drawings and as specified herein. Systems shall include piping, valves, system specialties and accessories.

1.2 Piping systems shall conform to ANSI and State rules for pressure piping where applicable. Welders and fitters shall be fully certified for work performed.

1.3 Safety valves and all pressure vessels shall bear the appropriate ASME label.

1.4 Refer to Section 23 05 07 Piping Materials and Methods, Section 23 05 23 General Duty Valves for HVAC Piping, Section 23 05 29 Hangers and Supports for HVAC Piping and other related sections for required provisions.

PART 2 - PRODUCTS

2.1 Pipe, fittings and joints for the hydronic systems shall be as listed below and as described in Section 23 05 07 Piping Materials and Methods.

2.2 Piping for the various service shall be:

A. Hot water
   1. Black Steel - Type S1
   2. Copper – Type C1 C2.

2.3 General duty valves for the various services shall be as listed below and as described in Section 23 05 23 General Duty Valves for HVAC Piping:

A. Shutoff
   1. Butterfly - Type A1, A2.
   4. Gate - Type D1, D2.

B. Check
   1. Swing - Type C1, C2.
   2. In-line Spring - Type C3, C4.

C. Balancing Shut-off - Type E1, E2, E3.

D. Automatic Flow Controllers – Type F1.

2.4 Bolts for flanges in all high temperature (250 degrees F. and above) hot water piping shall be No. 7 hardened bolts.

2.5 Hydronic Specialties

PART 3 - EXECUTION

3.1 Drawings (plans, schematics and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, pipe expansion, and other design considerations; therefore, it is imperative that piping
be installed as indicated. However, deviations shall be anticipated & expected to accommodate field conditions and as such deviations shall be submitted in writing/diagram form for review by the Engineer prior to installation.

3.2 Refer to Section 23 05 01 Basic HVAC Requirements and other equipment sections for system cleaning and flushing requirements.

3.3 Refer to Section 23 05 07 Piping Materials and Methods for installation of piping and accessory devices and equipment.

3.4 For renovated systems and new systems connecting to existing it shall be anticipated that the existing systems will affect the new systems as far as cleanliness and therefore strainers shall be monitored/flushed daily, or more frequently if needed, until the systems are determined to be clean.

3.5 Air vents shall be installed at high points of piping and system, on each heating coil and at other locations subject to air binding. Air vents shall be installed in locations accessible for servicing. A shutoff valve or cock on the inlet and drain tubing extending from the vent discharge shall be provided for each large capacity automatic vent. The drain tube shall be extended to a drain location (floor drain, janitor sink, etc.) or, in mechanical rooms, turned down over a clear area of the floor to afford notice by maintenance personnel.

3.6 Install strainers as indicated on the drawings. Provide a nipple and ball valve in the blow down connection of each strainer 2 inches and larger.

END OF SECTION
PART 1 - GENERAL

1.1 Ducts, sheet metal plenums and associated devices, accessories and work items shall be provided as shown on the drawings and as specified hereinafter.

1.2 Ductwork, materials, construction, reinforcing and installation shall conform to SMACNA HVAC Duct Construction Standards, latest edition, and other applicable SMACNA standards. In addition, duct systems, components and accessories shall comply with applicable provisions of NFPA 90A, 90B, 96 and 255, and UL 181, 181A, and 181B, including smoke and flame ratings.

1.3 Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 Refer to the Duct Construction and Sealing Schedule on the drawings for information pertinent to the various duct systems, such as duct materials, SMACNA pressure class, seal and leakage class, external insulation, duct liner, etc.

1.5 Refer to the drawings for ductwork that is to be internally lined. Ductwork shall only be internally lined where scheduled or noted on the drawings.

1.6 Refer to 23 05 05 Firestopping for requirements related to non-fire dampered ductwork penetrating fire rated walls and partitions, and to 23 07 14 Fire Barrier Wrap for ductwork requiring such products.

1.7 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Sheet metal shall be lock forming quality galvanized steel, ASTM A924/A924M and A653/A653M, G60 coating designation, 24 gauge minimum, except as otherwise noted or specified. Other materials and construction for special applications required are as shown on the drawings and specified below. ASTM A653 G90 coating shall be used for ductwork located outdoors / and / (wet environment) as noted in the duct construction schedule on the drawings.

2.2 Ductwork, as noted on the drawings, that will remain exposed in finished areas and / on the roof which will be painted shall be fabricated of sheet metal with galvannealed or bonderized (phosphated) coating.

2.3 Stainless steel ductwork shall be Type 304, ASTM A167. Joints and seams shall be continuously welded except, on concealed ductwork, longitudinal seams and transverse joints may be sealed with aluminum silicone based sealant.

2.4 Aluminum ductwork shall be constructed of sheet aluminum, 3003 alloy H14 temper, ASTM B209/B209M, of increased thickness and reinforcement consistent with SMACNA standards, but minimum 18 gauge. Longitudinal seams on horizontal ductwork shall not be located along the bottom of the duct. Joints and seams shall be sealed with aluminum silicone based sealant.

2.5 When use is permitted per the Duct Construction Schedule on the drawings, fiberglass board duct systems shall be limited to concealed rectangular and round duct systems of 1 inch w.c. (positive and negative) and less static pressure construction classification. Refer to Duct Construction Schedule on the drawings. Fiberglass board duct systems shall be rated for +2 inches w.c. and shop fabricated of 1 inch thick R-4.2/1.5 inches thick R-6.0 fiberglass duct board, formaldehyde-
free, with foil faced vapor barrier jacket equal to Johns Manville “Enviro-Aire”, Type 475 or 800 for rectangular ducts, and similar rigid round pre-formed or shop fabricated fiberglass duct for round ducts. Duct system shall be UL 181 listed for Class 1 Air Duct and labeled as such. Staples and aluminum foil pressure sensitive tape, conforming to UL 181 A-P and printed as such on the face, shall be applied at joints and seams to provide closure and strength.

2.6 Flexible duct shall be installed as detailed on the drawings and shall not pass through any wall, floor, or ceiling. Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly.

A. Flexible air (duct) connectors for galvanized steel ductwork shall be:

Constructed of galvanized steel spiral wire mechanically locked to an airtight laminated aluminum foil, fiberglass and aluminized polyester duct fabric. Duct shall be rated at a minimum of 10 inches w.c. positive pressure and 4 inches w.c. negative pressure. Length shall be limited to 7 feet unless noted otherwise.

Insulated flexible duct shall have 1 inch thick R-4.2 / 1.5 inches thick R-6.0 fibrous glass insulation and .05 perm reinforced metalized vapor barrier outer jacket, equal to Flexmaster 5M. Insulated duct assembly shall conform to be UL 181 and listed as Class I Flexible Air Connector.

Non-insulated flexible duct shall be equal to Flexmaster NI-55, shall conform to UL181 and be listed as Class I Flexible Air Connector.

B. Flexible air (duct) connectors for aluminum ductwork shall be:

All aluminum construction equal to Flexmaster Type NI-TL. Duct shall be rated at a minimum of 10 inches w.c. positive pressure and 5 inches w.c. negative pressure, conforming to UL 181 and listed as a Class 0 Flexible Air Connector. Length shall be limited to 7 feet unless noted otherwise.

Insulated flexible duct shall have 1 inch thick R-4.2 fibrous glass insulation thermo sleeve and .05 perm reinforced metalized vapor barrier outer jacket, equal to Flexmaster M. Insulated thermo sleeve shall be factory installed or installed in the field by the contractor. Insulated duct assembly shall conform to be UL 181 and listed as Class I Flexible Air Connector.

Wet exhaust duct connected to cart washers, type II kitchen hoods, and other similar equipment shall not utilize flexible duct.

2.7 Interior duct liner for acoustical and thermal insulating purposes shall conform to ASTM C1071 and shall be GreenGuard Certified for low formaldehyde and low VOC emissions. Liner shall be 1 inch thick R-4.2 flexible fiberglass bonded with thermosetting resin. The interior (airside) surface shall be covered with a durable mat facing, which shall encapsulate the liner materials, provide a smooth face to the airstream and protect the liner from cuts and abrasions. The facing shall be treated with an EPA registered anti-microbial agent to reduce the potential for microbial growth. Edges of the liner shall be covered with an encapsulating coating to seal transverse liner edges and prevent surface flaring due to airstream. Noise Reduction Coefficient (NRC) for the liner shall be 0.70 or better. Liner shall not exceed 25/50 for flame spread/smoke developed per ASTM E84. Liner shall be rated for air velocities up to 5000 feet per minute and operating temperatures up to 250 degrees F. Note that duct sizes indicated on the drawings are inside clear dimensions, and that sheet metal dimensions are 2 inches greater in each dimension for rectangular ductwork, and 2 inches greater diameter for round ductwork. Liner shall be CertainTeed “Toughgard R’, or equal by Owens Corning, Johns Manville or Knauf.

2.8 Rectangular Ductwork
A. Elbows shall have an inside radius equal to the duct width. Where 90 degrees elbows are shown to be square on the drawings, they shall be square (mitered) with turning vanes, single vane type in lengths 32 inches and less, double wall in longer vanes, installed and supported per SMACNA. Elbows less than 90 degrees shall be radiused. Non-radiused elbows less than 90 degrees, with or without turning vanes, are not permitted.

B. Square Tee fittings shall include turning vanes. The widths of the two branch ducts shall add up to the width of the main duct, and the duct depths shall remain constant. Turning vanes shall be single vane type in lengths 32 inches and less, double wall in longer vanes, installed and supported per SMACNA.

C. Offsets and transitions shall conform to SMACNA. Unless shown otherwise on plans, transition angles shall be limited to 30 degrees on converging transitions and 15 degrees on diverging transitions.

D. Branch take-offs, where not detailed otherwise, shall be with a static boot (45 degrees clinch collar) per SMACNA. Straight tap take-offs are not permitted.

E. Divided flow branches shall conform to SMACNA. Bull head tees without vanes are not permitted.

F. Manufactured duct connectors similar to Ductmate Industries “25”, “35” and “45” may be used on rectangular ductwork except where welding or brazing is specifically required. Adhere strictly to manufacturer’s instructions. SMACNA duct gauge thickness and reinforcing shall be maintained when using this joining method, or the manufacturer’s requirements, whichever is more stringent. Connector components shall be constructed from same material as the duct section being connected.

2.9 Fan Transitions

A. Fan inlet – Maximum 7 degrees diverging and 15 degrees converging, and first duct elbow shall be minimum 2.5 fan inlet diameters away unless shown otherwise on plans.

B. Fan Discharge – Maximum 7 degrees diverging and 15 degrees converging, and first duct elbow shall be minimum 2.5 fan inlet diameters away unless shown otherwise on plans

2.10 Round and Flat Oval Ductwork:

A. Round and flat oval duct shall be factory or shop formed spiral lock seam, United McGill Air Products “Uni Seal” or “Uni Rib” or equal by Langdon, Semco, Tangent Air, Precision Duct or approved equal.

B. Acoustically lined round and flat oval duct shall be double wall spiral lock seam duct equal to United McGill Air Products “Acousti-k27” with solid/perforated liner and 1 inch thick R – 3.7 / 2 inches thick R-7.4 fiberglass insulation, or equal by Langdon, Semco, Tangent Air, Precision Duct or approved equal. Mylar film shall be included between insulation and perforated liner. Fittings shall be double wall insulated with solid liner, of construction similar to single wall fittings. Duct sizes list on the drawings are inside clear dimensions.

C. In lieu of the above, round duct, fittings and connectors may be Lindab “Safe” (single wall) or “ISOL” (double wall) duct systems with fitting ends factory equipped with double lipped “U” profile EPDM gasket. Spiral ducts shall conform to Lindab standards and shall be calibrated to published dimensional tolerances of Lindab. Insulation R-valves and liner types shall be as specified above.

D. Elbows and fittings for spiral lock seam round and flat oval ductwork shall be factory solid welded, equal to United McGill Air Products “Uni Seal” and “Acousti-k27” with beaded sleeve transverse joint connectors, or equal by Langdon, Semco, Tangent Air, Precision Duct or
approved equal. For duct systems classified at less than 3” w.c., elbows and fittings may be roll pressed type. Elbows shall be long radius type and, where shown, square type ells shall be mitered with turning vanes. Branch take offs shall utilize a 45 degree entry low loss tap or a conical lateral tap to minimize pressure loss, except that streamlined conical taps may be used where space constraints dictate. Tee fittings shall include elongated proportional turning vanes to equalize airflow around the ells. Wye branches shall be used at end of runs unless shown otherwise. Offsets and transitions shall conform to SMACNA. Transition angles shall be limited to 30 degrees on converging transitions and 20 degrees on diverging transitions. Divided flow branches shall conform to SMACNA. Bull head tees without vanes are not permitted.

E. Construction, reinforcing, supports, etc. shall either conform to SMACNA or to the duct manufacturer’s standards, whichever is more stringent.

F. Round duct of 1 inch and less (positive and negative) static pressure construction class may be longitudinal seam. Elbows for longitudinal seam round ductwork shall be factory or shop formed segmented standing seam or pleated. Other fittings shall be comparable to the elbows.

2.11 Air device duct connections for round duct branch connections to rectangular sheet metal ducts shall be 24 gauge sheet metal, equal to Flexmaster Series FL, straight side, minimum 24 gauge with and without manual damper, as described on the drawings. When manual damper is provided it shall be minimum 22 gauge with stamped re-enforcements and include .375” square shaft and locking quadrant equal to Ventlok 639 or Rossi “Everlock”, with 2” standoff and nylon bushings. Air terminal unit duct connections for round duct branch connections to rectangular sheet metal ducts shall be 24 gauge sheet metal conical type equal to Flexmaster Series CB. Connectors installed on interior lined rectangular duct shall have an integral insulation guard sleeve. Rectangular tap-to-round branch connection with static boot configuration shall be equal to Flexmaster Type STO. Similar fittings equal to Flexmaster Series DB and DC shall be used for fiberglass ductboard system. Buckley “Air Tite” fittings or similar by “Snap Rite”, equal to the specified Flexmaster fittings, with neoprene gasket and adhesive facing, additionally secured with minimum four sheetmetal screws, may be used for air device duct taps to rectangular sheet metal duct which is not internally lined.

2.12 Duct sealants containing asbestos are prohibited. All duct sealants, tapes and connectors shall be listed and labeled in accordance with UL 181A, 181B or 181C as applicable to the application. Duct sealant materials shall be one or more of the following (compatible with the application):

A. LEED Compliant solvent based sealers and mastics equal to Design Polymericics, with a maximum VOC content of 50 grams/liter.

B. Water base duct sealers and mastics equal to United McGill or Foster Products when the installation environment is above 40 degrees F.

C. Acetone based duct sealers and mastics, equal to Precision Adhesives, when the installation environment is between 0 degrees F and 40 degrees F, zero reportable V.O.C.’s.

D. Mineral impregnated fiber tape with liquid sealant duct joint sealer equal to that manufactured by Hardcast, Inc., Two Part II Sealing System, maximum V.O.C. of 135 g/l.

2.13 Duct Access Doors (Non-Grease Ducts)

A. Access doors shall be factory fabricated constructed of the same material as the ductwork (except galvanized sheet metal for fiberglass duct), complete with hinged door, cam lock latches, frame and neoprene gasket between door and frame. Doors in insulated ductwork (internal and external) shall have double wall insulated doors. Access doors shall be 16 inches x 16 inches minimum except smaller where duct size will not permit such size. Each
access door shall be provided with a 7 inches round or equivalent view window, double pane if duct is required to be insulated or if required for pressure rating.

B. Access doors and panels shall be designed to provide tight seal commensurate with the duct pressure. Apply duct sealer or rubber gasket between frame and duct. On ducts of 3 inches S.P. and higher construction class, mechanical fastening of the frame and rubber gasket shall be provided.

C. Where sufficient clearance is not available to allow the door to swing open 90 degrees, an access panel with neoprene gasket, frame, chain connected to both the panel and ductwork, and cam lock latches on all four sides shall be provided in lieu of the hinged door.

2.14 Plenum access doors shall be factory fabricated and as described for duct access doors except that doors shall be 18 inches x 48 inches (unless otherwise noted) with overlapping frame, continuous piano hinge and heavy duty latches (with lever on both outside and inside) equal to Ventfabs “Ventlok No. 202. Two latches shall be provided except on doors 50 inches and higher three shall be provided. Frame shall be mechanically fastened to the plenum wall.

2.15 Ductwork that crosses building seismic joints or expansion joints shall be fitted with flexible connectors that will accommodate the building movement in all directions. Refer to structural drawings for required displacements. Connectors shall be manufactured by Mercer Rubber or approved equal, multiple plies and arches of elastomer-impregnated fabric or cord, EPDM construction with mounting flanges, all rated for 250 degrees F service at pressure rating consistent with the associated duct system. Refer to duct construction schedule. Grease ductwork shall not be fitted with flexible connectors.

PART 3 - EXECUTION

3.1 Duct thickness, construction, reinforcing, support and installation shall conform to SMACNA HVAC Duct Construction Standards, latest edition and other applicable SMACNA standards. Duct reinforcing shall be external to the duct except that rectangular ducts of 3 inches s.p. class or greater with a dimension exceeding 48 inches may utilize internal tie-rod supports in accordance with SMACNA. Only round tubing, rods or conduit is permitted as tie-rods, utilizing the minimum diameters required by SMACNA.

3.2 Transverse joints and longitudinal seams shall be assembled with sealant to conform to SMACNA sealing requirements as indicated in the Duct Construction Schedule on the drawings. Selection of sealant materials shall be compatible with the application. Sealants shall be applied in accordance with manufacturer's recommendations, including application temperature ranges.

3.3 Attachment of hangers and straps to the structure shall be with:

A. Pre-set concrete inserts in concrete construction of 4 inches minimum depth.

B. After-set concrete inserts, in 4 inches minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

C. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment.

D. Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.

E. Unistrut type channel support system may be utilized. Channel shall be pre-set or attached to the structure with inserts or clamps.

F. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical.
This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

G. Attachment to manufactured trusses, purlins and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

3.4 Ductwork outside shall be sealed with mineral impregnated fiber tape. Ductwork shall be supported per SMACNA and as noted or detailed on the drawings. Ductwork, whether externally insulated or not, shall be jacketed as specified in 23 07 13 Duct Insulation.

3.5 Ductwork with galvannealed or bonderized coating shall be wiped clean to remove dirt, dust, oil and other contaminates in the shop before delivery to the jobsite. Care shall be taken in storage and installation to maintain cleanliness of the surfaces. Prior to painting, again wipe the surfaces clean.

3.6 PVC coated ductwork shall be thoroughly inspected and repair spray applied to cut edges and damaged coating. Duct sealants and repair spray shall be compatible with the product and applied per manufacturer’s instructions.

3.7 Fiberglass board ductwork shall be constructed and installed in accordance with SMACNA standards. Joints shall be stapled and sealed with UL 181A-P aluminum foil duct tape with UL listing printed on the face. Fiberglass board ductwork shall not be installed:

H. Thru any wall, ceiling, floor or fire rated assembly.
I. In the immediate vicinity of, and connecting to, air devices in fire rated ceilings where the assembly details require steel ductwork.

3.8 Flexible air (duct) connectors shall be attached to metal duct with Panduit nylon banding straps or stainless steel clamps. Nylon banding straps shall be tightened utilizing a cable tie gun. Outer jacket of insulated flexible duct shall be closed at the ends with sealant and nylon banding straps or U.L. listed aluminum foil duct tape equal to Nashua No. 617022 with UL 181 listing printed on the face. Maximum length shall be 7 ft. with support at 4 ft. maximum spacing. Duct shall be free of sags and sharp bends. Utilize flexible duct elbow supports at all elbows. Flexible supports shall be UL listed for ceiling return air plenum use per UL 2043, UL 723 or ASTM E84, as manufactured by Titus (Flexright) or Thermaflex (Flex Flow) or approved equal. Independently supported radius’ed sheet metal elbows may be used in lieu of flexible duct elbow supports when installed directly on air devices.

3.9 Flexible air (duct) connectors shall not be installed:

A. Where ductwork is exposed.

B. Thru any wall, ceiling, floor or fire rated or smoke rated assembly.

C. In the immediate vicinity of, and connecting to, air devices in fire rated ceilings where the assembly details require steel ductwork.

3.10 Interior duct liner shall be installed at time of ductwork fabrication. Liner shall be installed in strict accordance with the manufacturer’s instructions and SMACNA standards. Liner shall provide full coverage of the ductwork, with all edges neatly butted together without gaps or interruptions. Adhesive shall cover at least 90 percent of the sheet metal surface. In addition, mechanical fasteners shall be utilized where required by SMACNA standards, NAIMA standards, or the liner
manufacturer. Fasteners for flexible polyimide liner shall have beveled or cupped contact edges. Fasteners shall not compress the liner more than 10 percent of the liner thickness. Length of fastener pins for flexible polyimide liner shall equal liner thickness within 1/16 inch. Raw exposed liner edges resulting from shop cutting of the liner shall be treated with a sealant to protect the fibrous liner material from moisture or erosion due to air movement. Provide metal nosing at the leading edge of transverse joints at fan discharge and any joint preceded by an unlined section of ductwork. In addition, metal nosing is required at every transverse joint when the air velocity exceeds 3000 feet per minute. Repair any damage to liner coating with repair sealant/coating approved by the liner manufacturer. Protect liner and lined ductwork from dirt and moisture during fabrication, transport and storage, as well as during and following installation of the ductwork.

3.11 Duct and plenum connections to air supply, return or exhaust units and fans (other than power roof ventilators or any Type I grease duct fan) shall be made with a 4 inches wide intervening section of flexible incombustible fabric equal to Ventfabrics "Ventglas", to prevent the transmission of fan noise and vibration to the ductwork. Fastening shall consist of angle clamps and bolts made up to be air tight similar to Ventfabrics "Metaledge". Duct connections to Type I grease duct fans shall be flanged and gasketed with material rated for no less than 1500 degF.

3.12 Duct access doors shall be provided for access to equipment, damper operators, devices and instruments inside the duct, at each fire damper, smoke damper and duct smoke detector (refer to Electrical drawings) and where otherwise shown. A wall or ceiling access panel shall be provided where duct access is required thru a wall or inaccessible ceiling. Refer to 23 05 04 Basic HVAC Materials and Methods for such access panels.

3.13 Access door and fire damper shall be so arranged and located such that the spring catch and fusible link are accessible when the damper is closed. The door shall be sized to permit entry of arms or body in resetting of the damper. Special consideration must be given for larger dampers and spring loaded horizontal dampers.

3.14 Coordinate openings required for the passage of ductwork thru walls, partitions, floors and roofs with the General Contractor. Sleeves are not required except as stated below.

3.15 Floor sleeves for ductwork shall project 4 inches above the finished floor in equipment rooms and areas of similar usage, and shall form a waterproof seal. Exceptions shall be at locations where the opening is protected from drainage falling thru by means of concrete curbs or shaft walls. Provide 4 inch high x 4 inch wide concrete curbs with beveled edges to protect floor openings related to work in equipment rooms or an equally effective waterproofing metal curb.

3.16 Sheet metal sleeves in conjunction with fire dampers shall be placed in walls and floors to pass ductwork.

3.17 Where a fire damper is not required in a duct penetrating a fire rated wall or partition, the opening shall be fitted with a sleeve conforming to the requirements of the firestopping assembly. Refer to 23 05 05 Firestopping.

3.18 Annular spaces around ducts or duct insulation passing thru non-fired rated walls and partitions shall be closed with caulking or other compatible material to retard the passage of smoke. Annular spaces around ducts not fitted with fire dampers that pass thru non-fire rated floors shall be similarly closed.

3.19 Stored ductwork shall be blocked up off the ground and completely covered with visqueen. Open ends of both stored and erected duct shall be capped or covered with visqueen secured with duct tape before the end of each day’s work to preclude contamination or entry of foreign materials. Factory made covers with elastic banding as manufactured by Duct Cap are also an acceptable means for temporary duct closure.
3.20 The duct system shall be free of construction debris and new ductwork shall comply with level “B”, the Intermediate Level of the latest edition of the SMACNA Duct Cleanliness for New Construction Guidelines.

3.21 Where duct surfaces can be seen thru grilles, registers and diffusers, the inside of the duct shall be coated with flat black paint before the device is installed, to eliminate obtrusive appearances.

3.22 Ductwork and piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment in accordance with The National Electric Code.

3.23 Coordinate duct layout carefully with other trades to avoid conflict with structural elements, lighting and plumbing heating piping. Flattening of ductwork and offsets to fit ductwork in available space is generally shown. In the absence of such, arrange the ductwork to maintain concealment and allow ceilings and lights to be installed as intended. Do not hang ductwork until possible interference with electrical and mechanical trades have been resolved. Having ductwork fabricated and delivered in advance shall not be justification for interference with other trades.

3.24 Provide a complete set of ¼ inch = 1 foot 0 inch sheetmetal fabrication drawings. The drawings shall be used for overall coordination with the other trades. Meet with the other trades prior to developing and finalizing these drawings. The ¼ inch sheet metal drawings shall be true fabrication drawings started “from scratch” in that direct duplication of the contract drawings will not be accepted. In addition to plan layouts, fabrication drawings submitted for review shall include the following:

A. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.

B. Duct layout, indicating pressure classifications and sizes in plan view.

C. Fittings.

D. Reinforcing details and spacing.

E. Seam and joint construction details.

F. Penetrations through fire rated and other walls.

G. Terminal unit, coil, humidifier, and other air-side equipment installations.

H. Hangers and supports, including methods for building attachment, vibration isolation and duct attachment.

END OF SECTION
1.1 Ductwork accessories specified herein shall include, smoke dampers. Refer to the drawings for scope and application.

1.2 Fire dampers and smoke dampers shall be provided where shown on the drawings and where otherwise required to conform to the NFPA 90A and Building Code requirements.

PART 2 - PRODUCTS

2.1 Smoke dampers shall be as manufactured by Ruskin, Greenheck, Nailor or Carnes, constructed and tested to conform to UL 555S, shall be UL labeled and rated for use in dynamic systems. Dampers shall have center pivoted multiple blades complete with blade and jamb seals and factory furnished and installed two-position actuator and linkage with end switch (for positive proof open). Tied to the B.A.S., and remote test station. Remote test station shall include L.E.D. indicator lights for damper status (open/closed) and keyed switch to cycle damper to normal/closed damper positions. The actuator shall be a 120-volt AC electric operator, externally mounted unless noted otherwise, arranged for powered opening and spring return closing of the damper. Junction boxes shall be sized per NEC to accept all power and control wiring. Dampers shall have airfoil blades and AMCA certified for Leakage Class I (4 cfm/sq. ft. at 1 inch S.P.). Pressure level construction shall conform to that of the duct as indicated in the Duct Construction Schedule on the drawings. Blades shall either be horizontal or vertical as the application dictates, and in conformance with its UL listing. Static pressure loss at 1000 fpm for a 24 inches x 24 inches damper shall be maximum .03 inch w.c.. Dampers that are installed in "out of wall" or "out of floor" conditions shall be designed, listed and labeled for such applications. The contractor shall provide "out of wall" and "out of floor" dampers as indicated on the drawings and as required for adequate access.

2.2 Dampers used as part of the smoke control system shall be designed, listed and labeled for the application and shall be “reopenable” by command from the fire alarm system/BAS. Smoke dampers and combination fire/smoke dampers used as part of smoke control system shall be provided with a factory installed heat responsive device with electric actuator equal to Ruskin TS150 Firestat as part of the smoke damper assembly.

PART 3 - EXECUTION

3.1 Fire and smoke dampers shall be installed in conformance with manufacturer's instructions and SMACNA recommendations. Dampers shall be installed in sheet metal wall or floor sleeves along with retaining angles and duct access doors or panels. Sleeve and duct connections shall be breakaway type or rigid type with corresponding gauge requirements in accordance with the manufacturer's instructions and SMACNA recommendations. Provide a duct access door for each damper, minimum 12”x12” or removable duct section (bolted and gasketed double wall duct section) per NFPA 80 and labeled “FIRE DAMPER”, “SMOKE DAMPER”, or “FIRE–SMOKE DAMPER” as appropriate.

Ceiling radiation dampers shall be installed in accordance with the details listed in the fire-resistance-rated assembly and the manufacturer's installation instructions and listing.

3.2 Coordinate Smoke detectors associated with smoke dampers and required power source for smoke dampers. Coordinate with the smoke detector manufacturer the minimum duct size and velocity requirements for proper detector operation prior to duct installation. Provide any required duct changes for smoke detector installation. Provide duct access doors and ceiling access panels for inspection of each smoke detector and insertion tube. Smoke detector initiation signals or smoke zone inputs associated with smoke dampers shall be provided to the building’s automatic temperature controls from the fire alarm system. Extend power from sources (J-boxes) provided under Division 26. Provide control wiring, relays and control functions as part of the building’s automatic temperature controls. Refer to 23 09 93 for smoke damper control sequences.
3.3 Fire dampers and smoke dampers and associated access doors shall be so arranged and located such that the spring catch and fusible link, operators and reset buttons are accessible when the damper is closed.

3.4 Accessibility of each fire damper shall be demonstrated to the Owner by disconnecting the link, closing the damper, reopening and re-attachment of the fusible link. Operation of each smoke damper shall also be demonstrated.

3.5 Each smoke damper end switch shall be extended to the B.A.S. for monitoring/status purposes. Coordinate with the B.A.S.

3.6 Each smoke damper and fire/smoke damper test station shall be mounted in a double-deep j-box recessed in the ceiling below its associated damper. Power wiring to the damper shall be extended thru the test station in accordance with damper manufacturer’s wiring instructions. Wiring shall be included in Division 23 / 26 / 27, run in conduit.

3.7 Fire damper proving switches shall be installed, adjusted for proper operation and tested.

END OF SECTION
PART 1 - GENERAL

1.1 Fans shall be provided as specified below and shown on the drawings, complete with motors, drives and associated devices.

1.2 Fans shall be constructed, rated and labeled in accordance with AMCA Standard 210-67 and AMCA 300. Fans shall be statically and dynamically balanced throughout the operating range. The class of the fan provided shall be adequate for the duty specified plus a 25 percent increase in static pressure. Shop drawing submittals shall state maximum fan RPM for fan class provided. No infringement will be allowed on this requirement. Submittals shall include fan curves showing operating point(s), system curves, and surge lines.

1.3 Fans with Electronically Commutated Motors (ECM’s) shall be selected such that the maximum available motor RPM shall at minimum accommodate 10% additional fan CFM at a 21% increase in fan static pressure, over what is specified as the duty point. This elevated performance point shall also not exceed the motor’s Hp limitations or the fan’s construction class. Shop drawing information shall reflect these requirements. Motor speeds shall be adjustable in the field, and any hard programmed limitations of motor speed or fan performance shall be based on the required elevated performance stated above.

1.4 Classification for Spark Resistant Construction shall conform with AMCA 99.

1.5 Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment and Section 23 05 31 HVAC Equipment Drives for required provisions.

1.6 Refer to Section 23 05 49 Vibration Control for HVAC for vibration isolator types.

1.7 Provide dimensional drawings and product data on each exhaust fan assembly. Provide fan curves for each fan at the specified operation point with the flow, static pressure, and horsepower clearly plotted. For multiple fan assemblies, fan curves shall be adjusted to show assembly operation.

1.8 Dampers shall be tested and licensed for air performance and leakage in accordance with ANSI/AMCA standard 500-D and AMCA publication 511.

1.9 Fans serving type 1 exhaust hoods or connected to grease duct systems shall be UL listed for grease duct applications and come with grease drain/reservoir, and backdraft and balance dampers shall not be installed in grease duct systems.

1.10 Equipment shall carry an all-inclusive manufacturer’s parts and labor warranty for a period of one (1) year(s) from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. The all-inclusive parts and labor warranty for ECM’s and associated controllers shall be for a period of 5 years. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner, including any required replacement of fluids, glycol, or refrigerant. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer’s authorized service agent.

1.11 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Induction motors 1 HP and larger shall be "premium efficiency" series motors. Motors shall be 1750 rpm unless specifically noted otherwise. Drives and couplings shall be protected with guards conforming with OSHA standards. Motors connected to VFD’s shall comply with 23 05 13 Electrical
Requirements for HVAC Equipment and shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer. Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment.

2.2 Electronically Commutated Motors (ECM’s) shall be maximum 1750 rpm unless specifically noted otherwise. Refer to 1.3 above and Section 23 05 13 Electrical Requirements for HVAC Equipment. ECM’s shall be variable speed motors with motor-mounted interface with manual potentiometer that allows minimum 5:1 turn down of motor speed, setting of minimum motor speed, and can accept a 0-10VDC signal from an external source to vary the motor speed.

2.3 The following lists types of fans, related construction features and manufacturers. All fans of any one listed type shall be of the same manufacturer.

A. Type D1 - Power Roof Ventilator
Power roof ventilator shall consist of a spun aluminum weather hood, counterflashing base, vertical shaft open centrifugal wheel, adjustable "V" belt drive (except fans with 13 inches dia. or smaller wheel may be direct drive) resiliently mounted motor, motor disconnecting means in the motor compartment, motorized backdraft damper and bird screen.

The exterior of the fan shall be factory primed and painted with a semi-gloss enamel, color selected by the Architect.

A metal roof curb with straight sides and wood nailing on top shall be provided with each fan. Provide wood cant strips around the curb only if recommended for the roofing system. Curb shall be insulated type. Curb height shall be such that top of curb extends 12” above the finished roof surface. For sloped roofs, the curb shall have a built-in slope to match roof slope so that top of curb is level.

Fans shall be manufactured by Acme, Greenheck, PennBarry, Twin City, Cook, Carnes, TC Ventco or Jenn Air.

2.4 Motor HP shall be sufficient to handle the full load of the fan, including drive losses, at the selected condition without exceeding the motor rating. In no case shall the motor size be less than shown without prior approval from the Engineer. All motors greater than .083 HP but less than 1 HP shall be ECM motors or shall have a minimum motor efficiency of 70%. EC motors shall be provided with motor mounted speed pot control, 0-10 volt DC external speed control, and with a 24V transformer for external speed control and damper control with input voltage compatible with the fan motor voltage. Controllers shall be by the fan manufacturer / ATC. All motors 1 HP and larger shall be "premium efficiency" series. Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment.

2.5 Belt drive units shall have adjustable motor base, "V" belts and pulleys. Refer to Section 23 05 31 HVAC Equipment Drives.

2.6 Motorized backdraft dampers, where specified, shall be furnished with an electronic damper actuator with voltage compatible with the fan motor voltage and electric service to the fan. If not compatible, a transformer shall be provided with the fan and damper actuator to afford the appropriate voltage. Where the fan motor is fed from a Variable Frequency Drive controller (VFD) provide a control contactor or relay and extend the control from the VFD damper control output relay to open/close the damper when associated fan motor is started/stopped.

PART 3 - EXECUTION

3.1 Install fans and roof curbs level and plumb, in accordance with manufacturer’s written instructions. Support units as described below using the vibration control devices specified herein / in Section 23 05 49 Vibration Control for HVAC.

A. Base mounted unit: Set unit on equipment base using vibration isolators as specified. Secure unit to equipment base.
B. Roof curb mounted units: Set unit on the curb and fasten the fan base to the curb. Roof support curbs shall be installed and leveled and secured to the roof deck/structure. Roof insulation and roofing shall be installed at the curbs by the roofing Contractor / shall be removed and repaired to maintain the integrity of the roofing system. Provide wood cant strips around the curb only if recommended for the roofing system.

3.2 Arrange installation of fans to provide access space around fans for service and maintenance.

3.3 Adjust damper linkages for proper damper operation. Motorized backdraft dampers are to be wired to open when the fan operates. Coordinate with Division 26.

3.4 Fans with E.C. Motors shall be commissioned and set-up by a factory authorized technician to meet project requirements, and interface coordinated with the B.A.S.

3.5 Factory furnished devices which are not installed and wired in the factory shall be field installed and wired by Division 23, complete and ready for operation.

3.6 Perform the following operations and checks before start-up.

A. Remove shipping blocking and bracing.

B. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork and electrical are complete. Verify proper thermal overload protection is installed in motor starters and disconnects.

C. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation. Align belts and reinstall belt guards.

D. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.

E. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

END OF SECTION
PART 1 - GENERAL

1.1 Air control terminal units shall be pressure independent hot water reheat. Constant volume units shall be same as variable volume units except with a singular setpoint. Units shall be as specified below and shown on the drawings.

1.2 Control devices furnished with the automatic temperature controls are to be sent to the terminal unit manufacturer for factory mounting on the unit. Refer to the Instrumentation and Control for HVAC sections for controls and coordinate to provide a complete and operational system.

1.3 Unit sizes (inlet duct size) listed on the drawings shall be considered minimum. Where a larger size is required to meet noise or operational requirements, those shall be provided and noted as such on the shop drawing submittal. Resultant noise level from the control unit, ductwork and diffusers, as a system, shall not exceed a room NC level of 35 from both airborne and radiated noise, based on AHRI 885, with 1.5 inches static pressure at the inlet of unit at maximum cfm setting. Allowance for internally lined ductwork shall only be used when acoustic lining has been specified for ductwork downstream of the air terminal unit. Shop drawing submittals shall include NC ratings based on the specified inlet static pressure, and any corrective measures being taken / provided to comply with the NC level requirements. NC levels shall be calculated in compliance with AHRI 885 latest edition and all addendums.

1.4 Shop drawings shall include specific sound level calculations and necessary installation instructions (added acoustical treatment for ductwork, etc.) where added acoustical treatment is required to meet the specified room sound level.

1.5 Pressure drop thru the terminal unit and hot water reheat coil shall not exceed the maximum drop listed on the drawings. The coil face area shall be upsized if necessary to meet this requirement. The terminal unit casing shall be correspondingly upsized or the larger coil furnished separately. For a separately furnished coil an intervening duct transition, with internal insulation same as that in the terminal unit casing, shall be provided.

1.6 Because certain units may be sized for future duty, smaller inlet sizes shall not be acceptable unless approved by the Engineer.

1.7 Terminal unit performance shall be certified to comply with AHRI Standards 880 and 885.

1.8 Equipment shall carry an all-inclusive manufacturer’s parts and labor warranty for a period of one (1) year(s) from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner, including any required replacement of fluids, glycol, or refrigerant. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer’s authorized service agent.

PART 2 - PRODUCTS

2.1 Unit components and accessories shall consist of:

A. Unit casing shall be 22 gauge minimum galvanized or galvanealed sheet metal with beaded round inlet duct connection. Unless specified otherwise below, casing shall be lined internally with minimum R-3.0 insulation, fiber free or dual density fiberglass with neoprene facing. Lining shall meet UL 181 erosion standards and ASTM E84 (25/50) fire and smoke requirements. Edges, joints and other exposures shall be additionally coated or protected with metal edging.
B. Hot water reheat coil shall consist of copper tubes, aluminum fins and galvanized steel casing. Coil shall have AHRI certified ratings and shall be hydrostatically tested at 200 psi. Provide a manual air vent on the coil. Control valve shall be furnished with the automatic temperature controls.

C. Airflow control damper or valve shall have linear control characteristics and shall be 16 gauge galvanized steel or extruded or cast aluminum with gasketing and nylon bearings.

D. Velocity sensor shall be multi-point averaging crossflow type. The velocity sensor shall be mounted in the inlet air stream (both inlets for dual duct units) and shall amplify the airflow signal to provide accurate control at low, as well as high, inlet static pressure conditions. Required minimum static pressure of the volume regulator shall not exceed 0.25 inch w.g. for proper operation.

E. Airflow taps shall be provided to enable direct reading of total and static pressures. A conversion chart attached to each unit to convert pressure readings to airflow quantities. Caps for airflow taps shall not be directly mounted on hard tees. Provide 3” of poly tubing for each tap and place cap at end of tubing.

F. Casing leakage and damper leakage shall each not exceed 2 percent of maximum airflow cfm at 3.0 inches s.p. differential across the unit, when tested in accordance with ASHRAE 130.

2.2 Units shall be manufactured by Price, Krueger, Titus, Nailor, Trane, JCI, Metal Aire, Tuttle & Bailey.

2.3 Digital controller, damper operator and linkage, hot water control valve and room thermostatic sensor are to be furnished with the automatic temperature controls. Controller, damper operator and linkage are to be sent to the terminal unit manufacturer for factory mounting.

PART 3 - EXECUTION

3.1 Support the units from the building structure with steel hanger rods or sheet metal strap hangers from corner points of unit, minimum 4, such that unit is self-supporting. Units shall not be supported from the duct system or piping system or ceiling suspension system.

3.2 The air control terminal box locations must be coordinated with all elements that may be in or above the ceiling. This includes but is not limited to piping, conduit, wiring, junction boxes, pull boxes, lighting fixtures, sprinkler heads, cable tray, speakers, smoke detectors air devices, etc. In no case shall an air control terminal be mounted above a lighting fixture, speaker, diffuser or any other device mounted on the ceiling without written permission from the Engineer or Architect. Provide ceiling access panels where the ceiling system does not afford ready access.

3.3 Caps for airflow taps shall not be directly mounted on hard tees. Provide 3” of poly tubing for each tap and place cap at end of tubing.

3.4 Connect supply and return piping to each hot water coil with valves and unions. Provide a manual air vent at the coil.

3.5 Air control terminal unit supplier shall coordinate closely with the automatic temperature controls installer to ensure a complete, compatible and coordinated system of controls is provided. Furnish to the automatic temperature controls installer a complete job specific control diagram.

END OF SECTION
PART 1 - GENERAL

1.1 Air outlet and inlet devices include grilles, registers, diffusers, louvers and special air diffusion devices associated with ceiling and lighting systems.

1.2 Refer to the schedule on the drawings for description, catalog numbers, materials, finishes, accessories, mounting and other details of the devices required.

1.3 Supply air devices in ceilings shall have their backsides externally insulated for condensation control unless already internally insulated. This external insulation shall be factory installed, minimum R-4.2 mineral fiber with foil jacket.

PART 2 - PRODUCTS

2.1 Air distribution devices other than louvers and specialty products shall be Titus, Tuttle & Bailey, Kreuger, Price, Carnes, Metal Aire, Air Devices. All devices of a common type shall be by the same manufacturer.

2.2 Air outlet and inlet devices shall be equal to those specified by catalog number and description in the schedule on the drawings. Dampers shall be galvanized steel, unless otherwise noted, opposed blade configuration. Damper operators shall be concealed screw type. An auxiliary mounting frame shall be furnished with each grille and register except those mounted on exposed ducts or in lay in application.

PART 3 - EXECUTION

3.1 Verify & ensure compatibility of ceiling mounted devices with the ceilings and suspension systems (lay in, concealed spline, plaster, drywall, etc.). Verify with the architectural drawings.

3.2 Carefully align square and rectangular devices with the vertical and horizontal building lines. Diffusers shall be attached rigidly to the ductwork. Where connected by flexible ducts, special supports shall be provided as required, either from the ceiling suspension system or by independent suspension wires or rods from the building structure.

3.3 Externally insulate the backsides of supply air devices that are mounted in ceilings and not internally insulated. Insulation shall comply with 23 07 13 DUCT INSULATION.

3.4 Factory insulation on supply diffusers that is damaged prior to or during installing shall be repaired.

3.5 Inside of ducts behind grilles, registers and diffusers shall be painted flat black, as needed, to eliminate the sight of shiny surfaces.

3.6 Louver assemblies shall be installed in strict accordance with manufacturer’s recommendations. Louvers to be installed plumb, square, level and true. Blank off all unused portions of the louver with 14 ga. aluminum and insulate blank off with 1 inch rigid foil faced insulation. Seal blank off areas air tight.

END OF SECTION
PART 1 - GENERAL

1.1 The heating and cooling units shall be factory packaged rooftop cooling-heating units with circulating fan, gas fired heating section and air cooled refrigeration section. Units shall be roof curb mounted.

1.2 Units shall be rated in accordance with ARI Standard 270 and 360 and tested and certified by UL or ETL to conform to applicable ANSI standards.

1.3 Equipment shall carry an all-inclusive manufacturer's parts and labor warranty for a period of two (2) years (5 years for compressor and related refrigerant system) from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner, including any required replacement of fluids, glycol or refrigerant. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer's authorized service agent.

1.4 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Unit shall be specifically designed for outdoor rooftop installation on a full roof curb. Completely factory assembled and tested, piped, internally wired and shipped in one piece. Units are direct expansion cooling only with 100 percent economizer capability (including relief air), enthalpy controller. Provide non-fused disconnect switch and all operating and safety controls, furnished factory installed. All units factory run tested.

2.2 Unit casing shall be constructed of aluminum or galvanized steel, finished with two coats of weather resistant paint. Casing shall be minimum 1” thick double wall R-4 insulated type. Provide hinged access panels for access to filters, unit control panel, supply and return fans and other components needing service. Refrigeration components and compressor shall be accessible through hinged doors or removable panels. All access doors and panels shall be double wall construction with neoprene gaskets. Roof assembly curved or cross broken for natural drainage. All exterior seams shall be filled with sealant. Unit base shall have formed recess with factory installed flexible base to match roof curb assembly.

2.3 Units shall be roof curb mounted arranged for vertical air discharge and return. Refer to details on the drawings.

2.4 Indoor air circulating fan shall be airfoil centrifugal type with resiliently mounted motor, belt drive and adjustable pulley. Note particularly fan duty and HP requirements listed on the drawings.

2.5 Heating section shall be natural gas fired with powered burner, corrosion resistant stainless steel heat exchanger, spark igniting pilot, gas piping, manual and automatic gas valves on main and pilot piping, combustion safety controls and operating controls. The heating section shall have a minimum of two stages with a 2 to 1.

2.6 Refrigeration section shall consist of compressor(s), evaporator coil, condenser coils, condenser fans, refrigerant piping and devices. The compressor shall inverter scroll + fixed scroll type with spring mounting. Coils shall be aluminum fins bonded to copper tubes, all joints brazed, and shall have a minimum of two refrigerant circuits intertwined over the full face of the coil. Coils that are face-split or row-split are not acceptable. Condenser fans shall be direct driven propeller type with wire guards.
2.7 Units shall be rated under AHRI 210/240 and 340/360 and shall have minimum Energy Efficiency Ratings as specified below. Multiple or variable speed compressor units shall achieve this rating at high speed.

<table>
<thead>
<tr>
<th>Size (cooling)</th>
<th>Heat Source</th>
<th>Rating Condition</th>
<th>Min Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;65,000 Btuh</td>
<td>Gas</td>
<td>AHRI 210/240</td>
<td>14.0 SEER, 3.81 SCOP&lt;sub&gt;C&lt;/sub&gt;</td>
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<tr>
<td>65,000 – &lt;135,000 Btuh</td>
<td>Gas</td>
<td>AHRI 340/360</td>
<td>12.7 IEER</td>
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<tr>
<td>135,000 – &lt;240,000 Btuh</td>
<td>Gas</td>
<td>AHRI 340/360</td>
<td>12.2 IEER, 3.72 ICOP&lt;sub&gt;C&lt;/sub&gt;</td>
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<tr>
<td>240,000 – &lt;760,000 Btuh</td>
<td>Gas</td>
<td>AHRI 340/360</td>
<td>11.4 IEER, 3.40 ICOP&lt;sub&gt;C&lt;/sub&gt;</td>
</tr>
<tr>
<td>760,000 Btuh and greater</td>
<td>Gas</td>
<td>AHRI 340/360</td>
<td>11.0 IEER, 3.22 ICOP&lt;sub&gt;C&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

2.8 Motors 1 HP and larger shall be “premium efficiency” series motors. Motors connected to VFD’s shall comply with 23 05 13 Electrical Requirements for HVAC Equipment and shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer. Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment.

2.9 Pre-filters shall be 2” Merv 8 throwaway media filters. Final filters shall be 2” Merv 13 throwaway media filters.

Furnish one complete initial set of filters and one complete set of spare filters for each filter bank in the project. This is in addition to filters used for temporary heating.

2.10 Return air and outside air dampers and modulating controls shall be arranged for minimum outside air intake up to 100 percent outside air economizer cycle. Control package shall include a fully modulating return air/outside air electric damper operator, automatic enthalpy changeover control and adjustable mixed air thermostat. Also provide an Economizer Diagnostics Package that will initiate an alarm at the BAS indicating economizer malfunction. In addition a return air CO<sub>2</sub> sensor and control package shall control dampers to introduce sufficient outside air to maintain an acceptable low level of CO<sub>2</sub>. All dampers shall be neoprene or extruded vinyl edged for tight sealing. Outside air and vent air openings shall be weather protected and equipped with bird screening.

2.11 Units shall be furnished with exhaust fan and damper for powered venting, controlled in conjunction with the economizer cycle.

2.12 Roof curb shall be 24 inches in height, designed to match unit base. Curb shall consist of insulated steel, wood nailer, counterflashing, cant strip, and seals and gasketing to ensure weathertight installation.

2.13 Roof curb for each roof mounted unit shall be furnished with the unit, fabricated of steel with insulation, wood nailer, counterflashing, cant strip and seals for a watertight installation.

2.14 The unit shall be provided with an electrical system of controls for refrigeration, furnace and supply fan mounted in a unit control panel, wired and tested in the factory. Magnetic starters with overload protection shall be provided for each motor.

2.15 Packaged controls shall be provided with the unit as follows:

A. DDC based controller(s), stand-alone with network communication and interoperability with the LONworks Building Automation System (BAS). Controller(s) shall be LON compliant. WattMaster controls and controllers are NOT acceptable.

2.16 Control sequences shall be as follow:
A. RTU-1

1. System Description
   a. The air handling system consists of a supply fan VFD and airflow measuring station, exhaust fans with VFD and airflow measuring stations, mixing box with return air dampers and outside air dampers with airflow measuring station, exhaust air dampers, final filters, gas-fired furnace, DX cooling coil, and refrigeration system. Refer to the drawings for details.

2. System Enable Conditions:
   a. The “Occupied” mode of operation for this air handling system shall be in effect Monday through Friday, 7:00 a.m. to 5:00 p.m.. Verify and coordinate time of day scheduling with Owner. During the “Occupied” mode, the temperature controls shall function as specified. Refer to below for “Unoccupied” mode and “Override” mode.
   b. When a zone thermostat override button is energized, the air handling system shall be enabled to run in the “Occupied” mode for the duration of the override.
   c. Provide start-stop interlock between supply and exhaust fans. Schedule exhaust fans to run when the AHU is in the “Occupied” mode.

3. “Unoccupied” Night Setback Heating Mode
   a. When the air handling unit is in the “Unoccupied” mode and any zone temperature falls 3 degrees below the zone “Unoccupied” heating setpoint, the air handling unit system shall cycle on, except that the outside air dampers shall remain closed and the interlocked exhaust fans shall remain off. When all zone temperatures are at or above their zone “Unoccupied” heating setpoint the air handling system shall cycle off.

4. “Unoccupied” Night Setup Cool-Down Mode
   a. When the air handling unit is in the “Unoccupied” mode and any zone temperature rises 3 degrees above the zone “Unoccupied” cooling set point, or when space RH rises above 60%, the air handling unit system shall be cycled on for cool-down, except that and the interlocked general exhaust fans shall remain off. Provide wall mounted RH sensor as shown on drawings.
   b. During cool-down, outside air shall be used for cooling first unless the economizer is locked out. If the economizer is inactive, the associated relief and economizer exhaust fans shall remain off, and outside air dampers shall remain closed, and mechanical cooling shall be made available. When all zone temperatures are at or below their zone “Unoccupied” cooling setpoint the air handling system shall cycle off.

5. Adaptive Optimal Start
   a. An optimal start program shall start the unit in advance of the scheduled “Occupied” time to ensure proper space temperatures at occupancy time. The control learning algorithm at a minimum shall be a function of the difference between zone temperatures and occupied set points and the amount of time prior to scheduled occupancy. The algorithm shall adjust start times based on past histories and times to obtain occupied setpoints at similar outside air temperatures.
   b. During an optimal start warm-up cycle (“morning warm-up”) the outside air dampers shall remain closed, return air dampers full open, economizer exhaust fan off and
relief dampers full closed, and associated general exhaust fans off. During warm-up the VAV shut-off boxes shall open. This mode shall continue until the exterior zones (only) reach their “Occupied” heating setpoints. If the system is still in its warm-up cycle 30 minutes after the scheduled occupied start time, end the warm-up cycle and alarm the BAS of the zone(s) that did not hit their occupied heating set point. When the warm-up cycle ends, the economizer dampers shall be positioned to minimum and the respective exhaust fans shall be enabled. Economizer damper control shall be delayed two minutes during start-up to prevent cabinet heat from false loading the system.

c. During an optimal start cool-down cycle, outside air shall be used for cooling first unless the economizer is locked out. If the economizer is inactive, the associated relief and economizer exhaust fans shall remain off, and outside air dampers shall remain closed, and mechanical cooling shall be made available. This mode shall continue until all zones reach their “Occupied” cooling setpoints. If the system is still in its cool-down cycle 30 minutes after the scheduled occupied start time, end the cool-down cycle and alarm the BAS of the zone(s) that did not hit their occupied cooling set point. When the cool-down cycle ends, the economizer dampers shall be positioned to minimum and the respective exhaust fans shall be enabled.

6. Safeties

a. The following safeties shall be provided to stop the air handling unit system and position associated control devices to their "fail safe" position, i.e., outside and relief dampers closed, return dampers open. Safeties shall be wired into the fan starter circuit such that the safety shall function whether the starter selector switch is in the hand on or automatic position.

1) Low Temperature Limit Cutout "Freezestats" – Manual reset type. Shall be provided and installed on the leaving air face of the first coil in the air stream (unless otherwise noted) and shall stop the air handling unit system if a temperature below 38 deg F is detected. Refer to detailed installation requirements in 23 09 25 Instrumentation and Control Devices for HVAC.

2) Unit Smoke Detectors – Upon sensing smoke or products of combustion the air handling system shall be disabled. Smoke detectors shall be provided per Division 26 unless otherwise noted, installed in the return duct system and wired to the fan safety circuits to stop the air handling unit system upon smoke detection. Refer to the drawings for detector locations and coordinate their installation.

3) Supply Duct High Static Pressure Cutout - Provide a manually reset type duct static pressure switch, set at the maximum working pressure of the ductwork, to stop the fan system (supply, exhaust) on a rise in duct static above setpoint.

4) Return Duct High Negative Pressure Cutout - Provide a manual reset type duct static pressure switch, set at the maximum negative working pressure of the ductwork, to stop the fan system (supply, exhaust) on a fall in duct static below setpoint.

7. Minimum Outside Air Control

a. This paragraph defines the operation of outside air, relief air and return air dampers (economizer dampers) to provide minimum outside air for ventilation. The phrase "Minimum" in the sequences of operation shall invoke this paragraph. Simple outside air damper sections (all damper blades operating in unison) shall open to a fixed position as determined by air balance and airflow station monitoring to provide
the specified minimum ventilation cfm set point. Return air dampers shall remain full open and relief air dampers shall remain completely closed.

b. System Demand Control Ventilation (SDCV) – The outdoor air cfm shall be measured by an airflow measuring station and modulated to maintain the minimum OA cfm setpoint. The minimum OA setpoint shall be the minimum minimum OA cfm specified in the AHU schedule unless reset upwards to maintain a maximum return air carbon dioxide (CO\textsubscript{2}) level as follows. Return air and outdoor air CO\textsubscript{2} shall be measured. The minimum OA cfm setpoint shall be reset between the specified minimum minimum and the specified maximum minimum to maintain a return air CO\textsubscript{2} level between 800 ppm and 1000 ppm, PID control loop.

800 ppm CO\textsubscript{2} or less - Minimum minimum OA Cfm

1000 ppm CO\textsubscript{2} or greater - Maximum minimum OA Cfm

If the return air CO\textsubscript{2} level rises above 1200 ppm an alarm shall be issued thru the BAS system. If the outdoor air CO\textsubscript{2} level rises above 500 ppm an alarm shall be issued thru the BAS system.

8. Differential Enthalpy Economizer Control

a. During “Occupied” mode or “Cool-Down” mode, outside air temperature and humidity, and return air temperature and humidity shall be measured, and the enthalpy of each determined. If the enthalpy of the outside air is less than the enthalpy of the return air, the economizer shall be enabled. When the outside air enthalpy is higher than the return air enthalpy, or when the outside air temperature is greater than 75 deg F, the economizer shall be disabled.

b. When the unit operates in the “Occupied” mode, the minimum outside air shall be provided, the return air dampers shall open full and relief air dampers shall remain closed. This condition is the normal position and shall be maintained during the “Occupied” mode except during the “Economizer” cycle. During the “Economizer” cycle, the amount of outside air and relief air shall be increased as required to maintain the unit discharge air temperature setpoint. Provide a mixed air sensor and low limit control set at 45 degrees F, to prevent over-opening of the outside air dampers. If the mixed air temperature falls below 45 deg F for 10 minutes and the outside air dampers are at minimum position, economizer shall be considered “inactive”. All control setpoints shall be fully adjustable to meet job conditions. Economizer Mode shall be delayed two minutes during start-up to prevent cabinet heat from false loading the system.

9. Outside Air Auto Damper Control

a. When the supply air fan is off for any reason or the unit is operating in the “Unoccupied” mode, warm-up mode, or cool-down mode the outside air damper shall be closed unless economizer is enabled.

10. Return Air Auto Damper Control

a. The return air damper shall modulate inversely to the outdoor air damper when the economizer mode is enabled. When the economizer mode is disabled the return air damper shall be fully open. Provide interlock so that the return air dampers and outside air dampers cannot be closed at the same time, under normal operation and off or failed operation.

11. Relief Air Auto Damper Control
a. Relief air is controlled by an economizer exhaust fan.

12. Supply Fan System Control

a. The supply fan system consists of a fan and associated VFD. Refer to 23 05 14 Adjustable Frequency Motor Controllers for VFD requirements.

b. A manual “Hand-Off-Auto” switch on the face of the VFD shall select mode of operation. When the selector switch is indexed to the “off” position, the associated fan system shall stop. When the selector switch is indexed to the “on” position and all safeties are normal, the associated fan system shall start and run continuously. When the selector switch is indexed to the “auto” position and all safeties are normal, the BAS shall start and stop the associated fan system.

c. A manual “Manual-Auto” switch (control pad feature) on the face of the VFD shall select control signal source for motor speed. When the motor is enabled and is indexed to the “Manual” position, the manual speed adjustor of the VFD shall provide the control signal for motor speed. When the motor is enabled and is indexed to the “Auto” position, the BAS shall provide a proportional plus integral control signal to modulate motor speed to maintain the supply air static pressure setpoint.

d. Supply Fan System Speed Control - The variable speed drives on the supply fan system shall be modulated by a duct-mounted static pressure sensor located two-thirds down the main supply duct, and a proportional plus integral control shall provide a signal thru the BAS to modulate the VFD speed to maintain the duct static pressure setpoint (initially set to 1.0” w.c.).

e. Supply Air Static Pressure Setpoint Reset

The supply air static pressure setpoint shall be reset by polling all VAV box damper positions. If all VAV box dampers are below 80 percent of full open, reset the supply duct static pressure setpoint downward 0.05” w.c. every 10 minutes until at least one VAV box damper is 85 percent of full open. If any box damper is more than 90 percent of full open, reverse the sequence (reset the static setpoint upward 0.05” w.c. every 5 minutes until all VAV box dampers are less than 90 percent of full open. Low limit of the setpoint shall be 0.50” w.c. and high limit setpoint shall be 1.20” w.c. Automatically detect those zones that may be excessively driving the reset logic and generate an alarm to the system operator. Readily allow operator removal of zone(s) from the reset algorithm.

13. Economizer Exhaust Fan System Control

a. The economizer exhaust fan system consists of fans and associated VFD, integral with the AHU. Refer to 23 05 14 Adjustable Frequency Motor Controllers for VFD requirements.

b. A manual “Hand-Off-Auto” switch on the face of the VFD shall select mode of operation. When the selector switch is indexed to the “off” position, the associated fan system shall stop. When the selector switch is indexed to the “on” position and all safeties are normal, the associated fan system shall start and run continuously. When the selector switch is indexed to the “auto” position and all safeties are normal, the BAS shall start and stop the associated fan system.

c. A manual “Manual-Auto” switch (control pad feature) on the face of the VFD shall select control signal source for motor speed. When the motor is enabled and is indexed to the “Manual” position, the manual speed adjustor of the VFD shall provide the control signal for motor speed. When the motor is enabled and is
indexed to the “Auto” position, the BAS shall provide a proportional plus integral control signal to modulate motor speed to maintain setpoint.

d. Economizer Exhaust Fan System Speed Control – When the air handling unit is on economizer cycle, the isolation auto dampers on the economizer exhaust fans shall open fully and the variable speed drive on the economizer exhaust fan system shall be modulated by a wall-mounted Dp sensor-transmitter to maintain a building pressure of +0.05” w.c., referenced to outdoors. Refer to drawings for Dp sensor location. Economizer exhaust fan and associated isolation dampers shall be closed when not on economizer.

14. Supply Air Temperature Set Point and Reset

a. The air handling unit components shall be sequenced to provide a supply air temperature of 70 deg F during “warm-up” cycles, and 54 deg F during “cool down” cycles. During “occupied” mode, the supply air temperature set point shall be 54 deg F except reset as follows:

1) Supply Air Temperature Reset Based on Zone Temperature: Poll all zones associated with this air handling unit every 15 minutes and the zone furthest from its cooling setpoint shall govern. As the worst-case zone deviation from its cooling setpoint decreases, the discharge air shall be reset upwards towards an upper limit of 60 deg F. If all zones are in heating and/or in dead band, the supply air set point shall be reset to the upper limit of 60 deg F. Automatically detect those zones that may be excessively driving the reset logic and generate an alarm to the system operator. Readily allow operator removal of zone(s) from the reset algorithm.

If return air relative humidity rises above 58 percent RH the reset schedule shall be deactivated. After 60 minutes, re-activate reset schedule if building RH falls below 55 percent. Provide return duct RH sensor for monitoring and reset control.

15. Gas-fired Heater – If the AHU fan system is “on” and the economizer is active, gas-fired heater to remain disabled. If the AHU fan system is “on”, the economizer is inactive and AHU supply air temperature falls 2 degrees below setpoint, modulate gas valve to maintain setpoint.

16. Cooling Coil Control

a. DX Coil – If the AHU fan system is “on” and the economizer is active and at 100 percent (outside air dampers full open) and the AHU supply air temperature is above set point, the solenoid valves and compressor stepping and speed shall be sequenced to satisfy the setpoint. If the AHU fan system is “on” and the economizer is NOT active and the AHU supply air temperature is above set point, the solenoid valves and compressor stepping and speed shall be sequenced to satisfy the setpoint. Provide on and off time delays between steps. Provide air flow switch wired in series with cooling control to keep cooling off unless the fan is operating.

2.17 Units shall be manufactured by Carrier, Trane, Daikin, JCI. The refrigeration system and furnace heat exchangers shall carry a five-year warranty.

PART 3 - EXECUTION

3.1 Roof curb shall be set in place, leveled and secured to deck structure. Units shall be installed with a solid roof deck below them and acoustic filler material between roof deck and floor of unit. Supply & return duct connects shall extend thru the curb and connected to unit via flex connectors (curb
shall not be used as a supply or return plenum). Cutouts of roof for supply and return ducts shall be caulked and sealed to prevent noise transmission.

3.2 Provide a concrete pad for grade mounted units. The supply duct housing shall be set on the pad, caulked air tight and the unit set on the housing.

3.3 Provide condensate drainage piping from the drain pan with a deep trap and cleanout as detailed on the drawings.

3.4 Coordinate power wiring with Division 26 thru a fused disconnect switch to one set of power terminals in each unit. Provide all required power and control wiring required for the completion of the systems. All wiring shall be run in 0.50 inch and larger conduit in accordance with applicable provisions of Division 26.

END OF SECTION
PART 1 - GENERAL

1.1 Unit heaters shall be hot water type units. Refer to the drawings for arrangement, type, capacity, motor characteristics and other requirements.

1.2 Provide electric components of terminal units which have been listed and labeled by UL.

PART 2 - PRODUCTS

2.1 Cabinet unit heaters shall consist of:

A. Direct driven centrifugal fans with multi speed permanent split capacitor motor having internal overload protection. A fan speed switch with "off" position shall be mounted behind a hinged access door and factory wired. The "off" position shall serve as a disconnecting means for both the fan motor and the controls or, in lieu of this, a toggle disconnect switch shall be furnished for mounting inside the cabinet.

B. Heating coil shall have seamless copper tubes with bonded aluminum fins, hydrostatically tested at 300 psi.

C. Concealed units shall have a discharge duct collar and where return ductwork is required, a return duct collar.

D. Disposable filter with cardboard frame, set in a channel frame.

E. Controls - Provide a low voltage transformer, unit on-off power switch and wall mounted thermostat.

F. Cabinet unit heaters shall be manufactured by Rittling, Trane, Modine, Airtherm or Sterling.

PART 3 - EXECUTION

3.1 Suspended units shall be hung from the building structure with steel hanger rods and auxiliary angles and fastening devices.

3.2 Provide all required wiring between the unit and wall mounted thermostats, in conduit per Division 26 and the N.E.C..

END OF SECTION
1. Give special attention on drawings as to arrangement of cabinet heaters - floor set, wall hung, recessed (semi and full, recess depth), location of grilles, etc.

2. Wiring between thermostat and unit is specified to be by the HVAC Contractor. If by Electrical Contractor, revise accordingly. Delete paragraph if thermostats are not specified with units or if specified as integral with units.

3. Disconnect means for the unit fan is specified with cabinet heaters (speed control switch with off position). Coordinate with the electrical designer to have the Electrical Contractor provide a toggle switch (same as a light switch) for HW, steam, and gas fired propeller heaters and a fused disconnect switch for electric propeller heaters. Caution not to mount switch on unit.

4. List of manufacturers (select only 3 or 4, generally):

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>HW - Steam</th>
<th>Electric</th>
<th>Gas</th>
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<td>Ray-Wall</td>
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5. Select "integral heating thermostat" in paragraph 2.4 C. or wall thermostat in paragraph 2.4 D. Verify availability of integral thermostat for specified units before including. Include "on-off-auto" switch with wall thermostat only where fan operation for air movement in summer is desired.
# COMMON WORK RESULTS FOR ELECTRICAL

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# LOW VOLTAGE ELECTRICAL TRANSMISSION

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MAY, 2019
PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions and Supplementary Conditions, including Division 00 and Division 01, apply to work specified in this Division.

B. The scope of the Division 26 work includes furnishing, installing, testing and warranty of all Division 26, and 28 work and complete systems as shown on the Division 26, and 28 drawings and as specified in Division 26, and 28 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors to the Prime Contractor, assignments of work by division are not intended to restrict the Prime Contractor in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

D. The project drawings and specifications define scope of work for the various divisions. Such assignments of work are not intended to restrict the Construction Manager in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in this Division. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the local jurisdictional authority.

1.3 Inspection of Site

A. Inspect the project site / and the / premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having bus duct, wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install bus duct, wireways, fittings and equipment.

D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork and piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces about Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance to Enclosures and Access to Work Space – 110.34 Work Space and Guarding. Caution other trades to comply with this stipulation.

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect’s decision shall be final in regard to the arrangement of bus duct, conduit, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.5 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 26 Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Architect who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.6 Coordination Drawings

A. The Division 23 Contractor shall initially prepare and be responsible for 0.25 inch scale coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format and distributed to the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using
common backgrounds obtained from the Architect and Structural Engineer. The Division 23 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings and that specified ceiling heights are maintained.

1.7 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.8 Record Drawings

A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work and within 90 days of system acceptance, these hand marked drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.9 Operating and Maintenance Manuals

A. Assemble three copies each of operating and maintenance manuals for the Electrical work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. Original purchase order number; date of purchase; name, address, and phone number of the vendor; warranty information.

E. Copy of required test reports.

F. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer Architect for review. Upon approval and within 90 days of system acceptance, manuals shall be turned over to the Owner.
1.10 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 26 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect and Engineer for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.11 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Use of equipment for temporary electric is not the start of the warranty period.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to, motor controller malfunction, heater element changes required for motor controller, fuse replacement where fuses blow due to abnormal shorts, adjustments and/or replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.
2.3 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will only be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.

D. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.4 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Shop drawings of the following equipment and materials shall be submitted:

1. Wireway.
2. Firestopping.
3. Pull boxes.
4. Miscellaneous cabinets.
5. Wiring devices and coverplates.
6. Panelboards.
7. Cabinets and enclosures.
8. Fuses.
10. Lighting fixtures and lamps.
11. Lighting controls/contactor and photocell
12. Fire alarm system.

PART 3 - EXECUTION

3.1 Testing

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. On all electric services including change-outs, backfeeds, etc. the Contractor shall verify phase rotation and voltage readings to ensure the final installation is proper. Submit to the Engineer in writing a record of voltage readings and current readings taken at no-load and fully loaded conditions.

D. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

E. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Submit four (4) copies of reports indicating results.

F. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.

G. Instruments required for tests shall be furnished by the Contractor.

3.2 Equipment Cleaning

A. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be performed in accordance with equipment manufacturer's recommendations.

B. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents; verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

B. Caution: Verify that all bearings of equipment furnished are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the other trades judgment in these matters. Follow specific instructions in regard to lubrication of equipment furnished under this Contract.
3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner, Architect and Engineer that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. A minimum of 8 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:

1. Show location of items of equipment and their purpose.
2. Review binder containing instructions and equipment and systems data.
3. Coordinate written and verbal instructions so that each is understood by personnel.
4. Separate instructions shall be given by manufacturer's representatives for the various special and communications systems.

D. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

END OF SECTION
PART 1 - GENERAL

1.1 The Engineer, at his sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer’s Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form. Charges are for the Engineer’s time to prepare the documents in the format stated. They are available through the Engineer’s office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor’s systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project’s name and address, the Architect’s / and / Engineer’s / and / any consultant’s name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor’s risk, and shall in no way alter the contractor’s Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer’s or its consultant’s computer software or hardware defects or errors; the Engineer’s or its consultant’s electronic or disk transmittal of data, information or documents; or the Engineer’s or its
consultant’s reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer’s consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney’s fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor’s distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached “Agreement” shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION
Project: Southdale and Orchard Park
Owner: Kettering City Schools

Heapy Engineering Project Number: 2019-07023
Heapy Engineering Project Manager: Dave Madden

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files.

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

   a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

   b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

   c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

   d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient’s receipt or use of the Electronic Files.
6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

   a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

   a. Are suitable for any other usage or purpose.

   b. Have any particular durability.

   c. Will not damage or impair the Recipient's computer or software.

   d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney’s fees, arising from or by reason of the Recipient’s use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient’s conversion or electronic file storage at the Recipient’s requested site, shall be at Recipient’s sole risk.
13. Recipient acknowledges:
   
a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.
   
b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose.
   
c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.
   
d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant’s consent may be assigned or transferred by Recipient to any other person or entity.

Provider (Name of Company):

Recipient (Name of Company):

Recipient Address:

Name of authorized Recipient Representative:

Title of authorized Recipient Representative:

E-mail address of authorized Recipient Representative:

Signature of authorized Recipient Representative:

Date:
NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: ________________________________

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ CD-ROM ☐ DVD-ROM ☐ Heapy FTP ☐ User’s FTP site ☐ Flash Drive

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:

☐ 2013 DWG

If a different file version is required than the indicated available version state the requested version:

______.DWG

Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 26 Electronic .DWG Files:

First Drawing: $50.00

Additional Drawings $15.00 each _________ x $15.00 = $ _________

Conversion to .DWG version different from available .DWG:

$5.00 additional/sheet _________ x $ 5.00 = $ _________

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _________

All files will be bound together.

Available electronic Revit file format:

☐ 2018 .RVT

Cost of Preparation of Division 26 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _________
1.1 Temporary Electric Services

A. The temporary service and temporary lighting for construction is provided by the Contractor. Refer to Division 01 - General Requirements.

B. The Contractor is cautioned to carefully consider the possible sources of temporary electric service and the probable location of the General Contractor's office.

C. The General Contractor will make application to the local utility company for the temporary electric service and will pay for all electric power used during construction, including electric heating.

D. The Contractor shall furnish, install and pay for all necessary conduit, wire, metering, poles, switches, receptacles, lights and accessories to provide a 400 amp, 120/208 volt, 3 phase, 4 wire temporary electric service with the main disconnect switch, meter, and a 42 circuit load center at a location specified by the General Contractor.

E. Consult the utility company for fees required and include same in Electrical Contract.

F. Labor, receptacles, boxes, fixtures, wire, etc. required by the various Contractors inside their offices shall be paid for by the respective Contractors.

G. Lighting fixtures shall be placed every 40 ft. along each corridor or where corridors do not occur, along the long axis of all rooms and areas greater than 25 ft. in length. Provide a 200 watt lamp in a rubber coated socket with wire guard, spliced into branch feeder conductor at every 20 ft. The branch circuit wiring may be 3 wire type "NMC" and the wire guard shall be bonded to the ground conductor. Receptacle circuits shall consist of 1 gang handy box with grounded duplex receptacles a maximum of 50 ft. on center with a maximum of 4 per circuit. All receptacle circuits shall be protected by its own overcurrent device in a panelboard. Install wiring and equipment above 6 feet 6 inches and below the finished ceiling. Extend circuits as required and protect in an appropriate panelboard on each floor level. Provide GFCI protected receptacles and circuits as required by NEC and OSHA.

H. Contractors requiring extension cords shall provide their own cords and plugs up to capacity of 20 amperes. For services to larger items of equipment and welders, this Contractor shall extend proper feeders as requested at the expense of the Contractors requiring the service.

I. The Contractor shall maintain the temporary light and power system for the duration of the work and shall remove it from the site when directed. Temporary wiring and equipment shall remain the property of the Contractor.

J. The use of the permanent electrical system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.

K. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.

L. The complete temporary service shall comply with Power Company, OSHA, and all Code requirements.

1.2 Continuity of Service
A. Work shall be so planned and executed as to provide reasonable continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch over, the Owner shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer to review the information with the Owner. Upon approval, final

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done outside of normal working hours.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devices and equipment requiring service or adjustment.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with industrial grade lock set. Locks in "secured" areas of the building shall have institutional grade locksets. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Acudor Style “UF-5000” or equal in non-public spaces.

2. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls, Acudor Style “DW-5015” or equal.

3. Standard flush type for drywall ceilings and walls, Acudor Style “DW-5040” or equal in finished spaces.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18 inches x 18 inches unless larger panels are shown or required. Panels shall be equal to Chicago Metallic Model CRG.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.
B. Electrical work shall be performed by a licensed Contractor in accordance with requirements of the jurisdiction.

3.2 Protection

A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where conduits, wireways, cable trays are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect. Any damage caused to the building shall be repaired or rectified.

C. Where conduits, wireways, cable trays are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching, refinishing and painting of same shall be included in this contract. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls etc. are to be cut for presence of existing utilities.

D. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system brace floor or alter location of new work to maintain existing system.

E. All sleeves and openings not used or partially used shall be closed to prevent passage of fire or smoke.

F. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

G. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

H. Engage a Roofing Contractor on a subcontract basis for roofing and roof insulation work necessitated by the Electrical work. The Roofing Sub-Contractor shall be certified for installation and repair of the roofing system so as to maintain the existing roofing warranty.

3.4 Removals, Alterations and Reuse

A. Refer to the drawings for the scope of remodeling in the existing building.
B. Cooperate with the General Contractor regarding all removal and remodeling work. The Contractor shall remove existing work which is associated with his trade, and which will be superfluous when the new system is installed and made operational. Void unused conduit behind walls or below floors as necessary or as directed. No wire or conduit shall be removed which will impair the functioning of the remaining work unless first replaced with a rerouted section of wire or conduit to ensure continuity. Remove inactive wiring back to the last active junction box, panelboard or piece of equipment.

C. Upon completion, no unused conduit or stub shall extend thru floors, walls or ceilings in finished areas. Abandoned conduit where remaining in place shall have any unused wiring removed. All accessible unused conduit shall be removed.

D. When it is necessary to reroute a section of an active circuit, the rerouted section shall be installed before removing the existing in order to minimize system down time. Rerouted sections shall be installed as required for new work.

E. Materials and equipment which are removed shall not be reused within the scope of this project unless specifically noted to be relocated or reused. Turn over to the Owner and place where directed on the premises all removed material and equipment so designated by the Owner. All material and equipment not claimed by the Owner shall become the property of the Contractor responsible for removal and shall be removed from the premises.

F. Remove, store and reinstall lay-in ceiling tile and grid as needed to perform work in areas where such removal and re-installation is not to be done by the General Contractor. Damaged tile and/or grid shall be replaced with new matching tile and/or grid.

G. In areas of minor work where the space is not completely vacated, temporarily move portable equipment and furnishings within the space as required to complete the work. Coordinate this activity with Owner. Protect the Owner's property by providing dust covers and temporary plastic film barriers to contain dust. Remove barriers and return equipment and furniture upon completion of the work.

H. Refinish any surface disturbed under this work to match existing, except where refinishing of that surface is included under the General Contract.

3.5 Painting

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 26:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.

2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.

3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.

4. Apply Z.R.C. Galvilit cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

5. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.

B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.
C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.6 Access Panels

A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Access locations thru HVAC ductwork must be coordinated with the ductwork installer. Location of the hinged access door with latch must be coordinated in advance with the HVAC Contractor.

C. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

D. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall/ceiling.

3.7 Backboards

A. Where shown on the drawings, backboards shall be provided for wall mounting of disconnect switches, devices and communications equipment. The Contractor may opt to mount additional groups of disconnect switches on backboards.

B. General

1. Backboard shall be 0.75 inch thick waterproof flame retardant plywood secured to structure.

2. Each board shall be painted.

3. Telephone backboards shall be normally 4 ft. x 8 ft. mounted 6 inches above floor where located on drawings. Where other sizes are required, they will be noted on the drawings.

C. Each terminal cabinet for communication systems, relays, etc., shall be fitted with a full size 0.50 inch thick backboard for mounting terminal strips, equipment, etc.

END OF SECTION
PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of conduits, bus ducts, cables, cable trays and other electrical items thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the OBC / Chapter 1, Section 106 and Chapter 7, Section 712 and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer’s engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer’s specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions. Submittals shall include all information required in OBC Chapter 1, Section 106 and Chapter 7, Section 712.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Rectorseal-Metacaulk, Tremco, Nelson, Specified Technologies or other approved manufacturer.

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer’s instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 26 05 33 Raceway and Boxes for Electrical Systems for sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION
PART 1 - GENERAL

1.1 This section pertains to the use of copper conductors, 600V insulation class.

PART 2 - PRODUCTS

2.1 All conductors shall be copper: conductors shall be insulated for 600 volts.

2.2 Insulation types referenced are those of NEC. All conductors shall be UL labeled and shall be marked for size and type at regular intervals on its length. Conductors #8 and larger shall be stranded; #10 and smaller may be stranded provided approved terminations are used.

2.3 Types of conductor insulation for general use may be any of the following, subject to limitations listed, in addition to those in the NEC:
   A. Type THHN - restrictions - do not use for conductors in slab. Do not use in wet locations.
   B. Type THWN - no restrictions.
   C. Type XHHW - no restrictions.

2.4 Use shielded VFD cables for feeds from VFD to motor where conductor length is longer than 25 feet. VFD cable shall be 3 conductor XHHW low capacitance copper, full size insulated copper ground, 1.5 mil AL foil and 85 percent tinned copper woven braid shield with PVC oil and sunlight resistant jacket. UL TC-ER, 90 degrees C., 600V wet/dry. Manufactured by Belden, AWC, Lutze or equal.

2.5 Use Type THHN or XHHW, (90 degrees C. rated) types for connecting fluorescent fixtures and for running thru fixture housings.

2.6 Use conductors such as type FEP with high temperature insulation as identified in the NEC for connections to resistance heating elements or in other areas subject to temperature exceeding the rating of THWN, XHHW or THHN.

2.7 Color Coding – The use of colored commercial building wire is encouraged.
   A. On 208/120 volt, three phase and 240/120 volt, single phase grounded systems, wires colored black, red and blue shall be used for phase conductors. Neutral wires on these systems shall be white. If conductors No. 4 AWG or larger are not available in white or white stripes, the neutral may be a black wire identified with white tape, minimum size 0.50 inch wrapped twice around at the following points:
      1. At each terminal.
      2. At each conduit entrance.
      3. At intervals not more than 12 inches apart in all accessible enclosures.
   B. Equipment grounding conductors shall be green, or for 4 AWG and larger may be completely taped green, at all accessible points.
   C. All control circuits shall be red with individual wire identification on each conductor.
   D. Where existing wiring systems (remodel work or building additions) have different color coding, consult the Engineer concerning matching existing wire color coding and phasing.
2.8 Wire size ampacity shall equal or exceed its overload protective device. Where wire sizes shown on the drawings are greater than the apparent ampacity requirements, the size shown shall prevail to compensate for voltage drop. In no instance shall conductors be installed that are less than required by N.E.C. Minimum conductor size shall be No. 12 AWG except No. 14 AWG may be used only for control wiring or where otherwise specifically shown.

2.9 When necessary to use a lubricant for pulling wires, lubricant must be listed by Underwriters' Laboratories, Inc. Only cable lubricants approved for the type of jacket material or insulation shall be used, and must be of such consistency that it will dry completely when exposed to air. Lubricant must leave no obstruction or tackiness that will prevent pulling out old wires or pulling in new wires or additional wires, and, after drying, must leave a film of lubrication which will promote easy movement of the wires. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes. Lubricant shall be Ideal "Yellow 190", 3M "WL" Wire Pulling Lubricant, or approved equal.

2.10 Splices No. 10 AWG and smaller shall be made using the following:

A. Preinsulated spring pressure connectors as follows: ITT Holub "Freespring", with metal grip threads 3M "Scotch-Lok", Ideal "Wingnut", Thomas and Betts Type "PT", or Buchanan "B Cap". Other hard insulated wire connectors which have bakelite or ceramic insulation are prohibited. (Non-metallic thread connectors shall not be used.)

2.11 Splices No. 8 AWG and larger shall be made using the following:

A. Approved crimp type connectors with special crimping tool; T&B, Burndy, Buchanan or approved equal. Joints and free ends shall be covered with tape or approved moistureproof insulating kits. Applied insulation shall exceed 150 percent of conductor insulation voltage rating.

B. For two or more taps use Power Distribution Blocks by Square D, Gould, Taylor, Ilsco or Connectron.

2.12 Wiring in vertical raceways shall be supported with strain relief devices; Kellem's grips or approved equal.

2.13 Connections to equipment shall be made with pressure type terminals. On stranded wire, use spade type terminals or terminals approved for use with stranded wire. Connections shall contain only single conductors unless approved for multiples.

A. For conductors No. 10 AWG and smaller, applied crimp type terminals shall be T&B "Sta Kon" or approved equal.

B. For No. 8 AWG and larger conductors, applied crimp type terminals shall be Burndy, T&B or approved equal.

2.14 Where tape is applied over wires and connectors on 600 volt or lower voltage applications, it shall consist of a minimum of two (2) half lapped layers of Scotch "88" or Plymouth No. 4240 for both indoor and outdoor applications, except Scotch 33 Plus or Plymouth No. 4453 is acceptable for use indoors.

2.15 Where fireproofing of cables is noted on the drawings or required by Code, each cable shall be arc and fireproofed with one (1) half lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape. Tape shall be secured with a 2 layer band of Scotch Brand 69 Glass Electrical Tape over the last wrap. Installation shall comply with manufacturer's recommendation.

2.16 Where installed underground, splices and terminations shall be listed and approved for waterproof application. Utilize kits approved for the application.
PART 3 - EXECUTION

3.1 Branch circuit conductor identification means shall be permanently posted at each panelboard and switchboard. This identification shall be installed on the inside of the door and shall identify conductor colors for each voltage system in the building. Provide identification at all new panelboards and existing panelboards utilized within this project.

3.2 Conduit systems shall be clear and clean before pulling wire. Branch circuit conductors shall be pulled without resorting to levers or heavy pulling devices.

3.3 Cable pulling tensions shall not exceed recommended values.

3.4 Group ungrounded and grounded circuit conductors for each multiwire branch circuit by cable ties in panelboards and tap boxes.

3.5 Each branch circuit or multiwire branch circuit shall have its own dedicated neutral. Group neutral conductors with phase conductors by wire ties in each enclosure where multiple neutrals provided.

3.6 Shielded VFD cables shall be provided for VFD to motor conductors length longer than 25 feet. VFD motor feed cables shall be terminated per VFD manufacturer’s direction.

3.7 Control conductors shall not be run in same raceway with branch circuit or motor circuit conductors.

3.8 Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only, ground conductors are not counted when determining maximum fill for this purpose.

3.9 Wire tags shall be provided on all main and feeder conductors in all pull boxes, wireways and panelboard and switchboard wiring gutters. Tags shall identify wire or cable number and/or equipment served. Tags shall be of flame resisting adhesive material, T&B Type WSL or approved equal.

3.10 Perform meggar tests on all feeders and motor branch circuit conductors prior to energization of circuits. Provide documentation in standard NETA format to the Engineer for review. Do not run meggar check on solid state equipment.

END OF SECTION
PART 1 - GENERAL

1.1 This section covers the use of aluminum conductors 600 V insulation class, in lieu of copper in certain limited instances as approved by the Engineer and Owner. Refer to Section "Conductors Copper" for color coding, tagging and basic installation requirements.

1.2 This section is applicable for feeders only in substitution for copper conductors in copper sizes #1/0 and larger. The use of aluminum conductors shall be limited to feeders. All feeder grounding conductors and bonding conductors shall be copper.

1.3 Conductor sizes shown on the drawings are based on copper. Ampacity of aluminum conductors shall equal or exceed those of the copper sizes shown.

1.4 The use of aluminum conductors entails larger conduit, gutters, boxes and wireways to meet code requirements. These enlarged sizes shall be a consideration in the application of aluminum conductors under this section.

1.5 Aluminum conductors shall only be used for feeders indicated as such on the drawings.

PART 2 - PRODUCTS

2.1 Aluminum conductors shall be stranded, 600 volt, with type THWN, THHN or XHHW insulation. Sizes shall be limited to ampacity of #1/0 copper and larger.

2.2 Oxide inhibiting paste - Burndy "Penetrox", Kearny "Kearnelex" or Ilsco "DE OX".

2.3 Connectors shall be long barrel compression type with minimum of two compressions per lug, one or two hole type as required, using appropriate dies and tools of size and type recommended by the manufacturer. Connectors by Burndy, T&B or Ilsco.

2.4 Where compression spade type terminals cannot be used, a compression termination to a "pigtail" of tinned copper shall be used; the copper "pigtail" can then be terminated in screw type terminals.

2.5 On conductors 500 Kcmil and larger, two hole crimp type lugs shall be used. Bolts shall be aluminum alloy 2024 T4 with compatible aluminum alloy nuts and washers. Where steel bolts are used, spring washers and heavy flat washers shall be used. Aluminum bolts shall be heavy shoulder shear type with National Standard coarse thread.

2.6 Connectors shall be submitted for approval before installation proceeds. Submittal shall include catalog numbers for each wire size and recommended tools and dies.

PART 3 - EXECUTION

3.1 Installation

A. All terminations shall be made with crimp compression connectors UL approved for the application, factory filled with inhibitor anti oxide paste; connectors shall be attached using a hydraulic press and dies. Set screw type connectors are not acceptable.

B. Aluminum conductors shall be prepared for connection.

1. Strip insulation with penciling tool - do not ring conductor with knife.
2. Remove oxide film with brush.
3. Note that an oxide film forms immediately on an aluminum surface after cleaning; therefore, it must be inserted into the inhibitor filled connector immediately after being brushed.

C. Clean the external connector face of the terminal pad after connection to the conductor, and coat with inhibitor paste before clamping to other pads or flat bars; this procedure applies also to surfaces on flat bars. Scratching must be omitted on flat tin plated surfaces; however, clean such surfaces with an etching type alkaline solvent cleaner.

D. For bolted connections between dissimilar metals, such as copper bus bars in panelboards and aluminum connector pads, use Belleville spring washers and plated heavy flat washers, one pair each side.

E. Use cast aluminum "slips" or terminal stacking adapters for connection of more than 4 lugs to a transformer spade type bushing terminal.

F. Perform megger tests on all feeders and motor branch circuit conductors prior to energization of circuits. Provide documentation in standard NETA format to the Engineer for review. Do not megger check solid-state equipment.

G. Provide non-destructive infrared testing and inspection of all aluminum terminations upon energization and again 60 days after startup under normal load. This is to determine if any early problems develop under full load. Provide NETA format documentation.

END OF SECTION
PART 1 - GENERAL

1.1 This section covers copper multi-conductor metal clad cable, Type MC. Metal clad cable constructions shall conform to UL #1569, UL 83 and N.E.C. Article 330.

PART 2 - PRODUCTS

2.1 Multi-Conductor Metal Clad Cable, Type MC, with copper conductors in sizes #12 thru #6 for continuous operation at a maximum conductor temperature of 90 degrees C dry. Cables shall have Underwriters' Laboratories labels for Metal Clad Cable and are suitable for use as branch circuits in both exposed or concealed work in accordance with the applicable sections of the National Electrical Code, Article 330.

2.2 Multi-conductor, Super Neutral, Metal Clad Cable, Type MC, with copper conductors in sizes #12 through #1/O AWG for continuous operation at a maximum conductor temperature of 90 degrees C dry. Super Neutral Cable, Type MC Cables are comprised of four or more conductors with one neutral per phase for three phase, a ground for four-wire power supply systems to receptacle circuits. Cables shall have Underwriters' Laboratories labels for Metal Clad Cable and are suitable for use in both exposed or concealed work or in accordance with the applicable sections of the National Electrical Code, Article 330. Receptacle circuits requiring separate neutrals, the neutrals shall be considered a current carrying conductor and derated per NEC 310.15.

2.3 Multi-Conductor Metal Clad Cable Conductors shall be copper type THHN with a full sized copper ground conductor and mylar assembly tape. MC cable type utilizing an integrated aluminum grounding/bonding conductor system as the equipment grounding conductor is not acceptable.

PART 3 - EXECUTION

3.1 Multi-Conductor Metal Clad Cable shall be supported and installed per NEC. Article 330. Except not permitted to be run exposed in finished spaces and the use of non-metallic ties for support is prohibited.

3.2 Plastic anti-short bushing (red head) shall be inserted into the armor cover at terminations.

3.3 Branch circuits from panelboards shall be run in conduit to a central junction box in spaces or group of spaces containing terminal blocks and ground bar where all incoming conductors and outgoing MC cable conductors are terminated. At these terminal blocks the transition is made to type MC cable with all terminal points identified along with the circuit numbers. The Multi-Conductor Metal Clad Cable runouts continue to lighting fixtures, receptacles, etc

3.4 MC cable shall not be run horizontally in walls between device boxes. Box-to-box wiring must go up the wall, over to the stud cavity for the next box and down the wall.

3.5 Conductors in central junction boxes shall be labeled indicating panel and branch circuit, refer to Electrical Identification; Section 26 05 53.

END OF SECTION
PART 1 - GENERAL

1.1 Work includes grounding and bonding of system neutral, equipment and conduit systems to conform to requirements of NEC and as detailed on the plans and in the specifications.

PART 2 - PRODUCTS

2.1 Clamps and continuity devices shall be non-ferrous material, UL approved. Connections to ground rods and all underground connections shall be "Thermoweld" or "Cadweld".

2.2 Ground conductors shall be insulated, identified by green insulation or by painting or taping green at all accessible locations and shall be connected with approved connectors and terminators to boxes, devices, equipment, etc. and to ground bars in panels.

PART 3 - EXECUTION

3.1 Wiring devices shall be connected with grounding jumper from ground pole on device to grounding screw in the outlet box.

3.2 Extend a minimum #4/0 copper ground cable from the ground bus in the primary service entrance equipment to the street side of the main water meter and to building steel, foundation footing steel (minimum 20 ft. length .50 inch or provide 20 foot #2 AWG, bare copper), driven ground rods outside or buried electrodes; increase ground conductor sizes where required.

3.3 In addition to using the conduit system for grounding, a complete auxiliary green wire equipment grounding system shall be installed, continuous from main ground, thru distribution and branch circuit panelboards and paralleling all feeders and branch circuit wiring. Grounding conductor sizes shall comply with NEC Table 250.122, minimum size shall be #12 copper except #14 on control circuits. This shall apply to all circuits rated 100 volts or more above ground potential.

   A. Connect ground terminal on wiring devices to auxiliary green wire equipment grounding system.

3.4 Motor frames shall be bonded to the equipment grounding system by an independent green insulated copper wire, sized to match equipment grounding conductor. Motors with VFD shall be bonded with flat braided tinned copper straps in lieu of wire.

3.5 Cord connected appliance frames shall be grounded to the equipment grounding system thru a green wire in the cord.

3.6 Equipment mounted on vibration isolation hanger and supports shall be bonded so bond does not transmit vibration. Size bond to match equipment ground conductor.

3.7 A green grounding conductor shall be installed in each non-metallic conduit and all flexible conduits, including exterior underground conduits.

3.8 System neutral connections shall be insulated from metal enclosures except at the neutral of the service entrance equipment and on the neutral of a separately derived system. Connections to the main switchgear enclosure shall be by means of bonding jumpers.

3.9 The building neutral shall be identified throughout with white conductors.

3.10 Steel frame buildings and metal exterior coverings on buildings that are not effectively grounded shall be grounded thru a low resistance grounding system whether or not a lightning protection system is required. Ground metal exterior coverings and metal roofs with minimum #4 copper
conductor at a minimum of two points, intervals not exceeding 100 feet. Ground steel frame buildings at each corner with maximum of every 60 ft. around the outside perimeter by cadwelding #2/0 (#4/0 for buildings over 75 ft. tall) copper conductor to steel columns and extending below ground to driven ground rods; top of 0.625 inch x 10 ft. ground rod shall be minimum of 12 inches below finished grade and 3 ft. out from building foundation. Bond the water service, street side of water meter, to the adjacent perimeter steel column with #4/0 insulated copper conductor. Sleeve all concrete foundations and masonry walls with PVC sleeve.

3.11 Where metal covers on pull boxes and junction boxes are used, they shall comply with the grounding and bonding requirements of NEC Article 250.

3.12 Connections to driven ground rods or other such electrodes shall be a minimum of three feet from the foundation wall or beyond the roof drip line, whichever is greater.

3.13 The electrodes (driven ground rods) of the electrical grounding system shall not be used for the electrodes for the lightning protection system, and vice versa. However, these two systems shall be bonded together at one point per NEC.

B. Test Values: The main ground electrode system resistance to ground should be no greater than five ohms.

3.14 Provide sign at normal service “WARNING – SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCES(S) IS ENERGIZED”.

END OF SECTION
PART 1 - GENERAL

1.1 Scope of Work

A. Work consists of pathways to carry communication wiring of all descriptions, including empty conduits, conduit sleeves, cable tray, cable management systems, etc.

B. Work includes support equipment for telecommunications cabling including backboards, rough-in boxes and cabinets.

1.2 Quality Assurance

A. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.

1.3 Shop Drawings – Submit shop drawings including product data sheets and diagrams per requirements including the following:

A. A complete list of materials with model and part numbers and reference to the specification paragraph number.

B. A complete set of detailed manufacturers specifications describing and illustrating all standard and special components and materials.

C. A complete set of drawings of special items. Submit drawings of cable tray and accessories including clamps, brackets, hangar rods, splice plate connectors, expansion joint assemblies, and fittings, showing accurately scaled components. Submit manufacturers data including, but not limited to, types, materials, finishes, width, rung spacings, inside depths and radii. For side rails and rungs, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).

D. Submittals that do not contain all this required information WILL BE REJECTED.

1.4 Drawings

A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc., is directed.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.5 Related Work by Others

A. Communications cabling shall be included as stated in the specification section for each individual system.

PART 2 - PRODUCTS

2.1 Conduit Systems
A. Refer to specification section 26 05 33 Raceway and Boxes for Electrical Systems.

2.2 Wireways shall be metal trough with a removable hinged cover and generous knockout arrangement. Provide necessary ells, tees and fittings for a complete installation. All components shall be hot dip galvanized after fabrication or provided with a rust inhibiting phosphatizing coating and finished in baked enamel. All hardware shall be plated to prevent corrosion. Wireways shall be manufactured by Square D, Weigman, Hoffman, Austin or Milbank.

2.3 Cable Tray (Wire Mesh / Basket – Steel)

A. General: Provide wire basket of types and sizes indicated; with all necessary horizontal and vertical bends, closures, junctions, connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

B. Materials and Finishes: Material and finish specifications for each wire basket type are as follows:

1. Paint: Straight sections shall be painted Telco Gray over Yellow Zinc Dichromate.
2. Pre-Galvanized Zinc: Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.
3. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.

C. All straight section longitudinal wires shall be straight (with no bends).

D. Wire basket shall be made of high strength steel wires and formed into a standard 2-inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

E. Wire basket sizes shall conform to the following nominal criteria:

1. Straight sections shall be furnished in standard 9 or 10 foot lengths.
2. Wire basket shall have a 4-inch usable loading depth by 12 inches wide with 12 inch radius.

F. All fittings shall be field formed as needed.

G. All splicing assemblies shall be the bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 stainless steel.

H. Wire basket supports shall be center support hangers, trapeze hangers or wall brackets as provided by the manufacturer and as otherwise indicated on the drawings.

I. Trapeze hangers or center support hangers shall be supported by minimum 3/8 inch diameter rods.

J. Special accessories shall be furnished as required to protect, support and install a wire basket support system.

K. Coordinate wire basket with other electrical work as necessary to properly interface installation of wire basket with other work.
L. Provide sufficient space encompassing wire basket to permit access for installing and maintaining cables.


2.4 Cable Management System

A. Provide pre-manufactured cable supports as manufactured by Panduit, Caddy, Eaton B-Line, Mineralac, Mono-Systems or Rayco. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

B. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bend, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

D. Bridle rings shall not be acceptable.

2.5 Rated Wall through Penetration

Fire-rated pathway shall contain built-in fire sealing system for installation in fire rated wall. The system shall automatically adjust to installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to adjust, remove or reinstall firestop materials. The pathway shall be UL classified and tested to ASTM E81H (UL1479) requirements. Ez-Path Series 44 or equal.

2.6 Cabinets

A. Telephone, communication and data systems cabinets shall be provided by the same manufacturer as panelboards with matching trim, hinges, latches, locks, finish and color unless included as part of another communication system specification. Refer to Section 26 24 16 “Panelboards” and Section 26 27 16 “Electrical Cabinets and Enclosures”.

2.7 Backboards

A. Refer to Section 26 05 04 – Basic Electrical Materials and Methods.

2.8 Rough-In Boxes

A. Refer to Section 26 05 33 – Raceway and Boxes for Electrical Systems.

B. Refer to drawings for types, quantities and configurations of outlet boxes used to serve communications cabling.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for pathway types, locations and routing.

B. Cable pathways shall provide the following minimum clearances:
1. Motors and transformers – 4 ft.
2. Conduit and cable used for electrical power distribution – 1 ft.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 5 kV – 5 inches.
5. Power lines over 5 kV. – 24 inches.

C. Backboards and cabinets shall be installed in telecommunications rooms/spaces to support telecommunications equipment and wiring. Coordinate locations of backboards and cabinets with Architect prior to installation.

D. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from area above suspended ceilings to respective backboards.

E. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.

3.2 Conduit Systems

A. No section of conduit shall be longer than 100 feet between pulling points.
B. No more than two 90 deg. bends in a section of conduit between pulling points.
C. Each section of conduit shall be labeled for length, destination closet and origination closet.
D. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.
E. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.
F. Provide a No. 12 gauge pull wire or nylon pull cord in each empty conduit run.

3.3 Wireways

A. Wireways shall be supported with factory made hangers designed expressly for this purpose and 0.375 inches diameter solid hanger rods approximately 5 ft. on center or approved strap hangers for surface mounting.

3.4 Cable Tray

A. Furnish all necessary horizontal and vertical bends, closures, junctions, devices, etc. normally recommended by the manufacturer and install same in strict accordance with their recommendations.
B. “Ladder Type” cable trays shall be supported from continuous wall inserts and shelf brackets in a manner to permit laying cables in the trays without interference of a supporting rod on one side. All inserts, supports and necessary wall modifications and bracing shall be furnished by this Contractor.
C. “Center Hung Type” and “Wire Basket Type” cable tray shall be supported from continuous overhead center rods or hangers compatible with the building structure and cable tray furnished and in accordance with manufacturers recommendations. Where cable tray is wall supported it shall be continuous with wall inserts and shelf brackets. Cable tray shall be installed to allow laying cables in both sides of tray without interference. All inserts, supports and necessary wall modifications and bracing shall be furnished by this Contractor.
Coordinate with the Architect and General Contractor and provide all required structural and wall modifications.

3.5 Cable Management System

A. The drawings do not indicate specific routes for telecommunications cables. The Division 27 Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Division 27 Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

B. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contractor shall be responsible for providing a cable management system. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 foot.
2. Conduit and cable use for electrical power distribution – 1 foot.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 2kVA – 5 inches.
5. Power lines over 5kVA – 24 inches cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.6 Rated Wall through Penetration

Where cable path is to penetrate fire rated walls a fire sealing system is to be installed. Provide multiple units equal to width of cable tray using a multi-gang kit.

3.7 Grounding

D. Each Telecommunications Closet (TC) shall be provided with a Telecommunications Ground Bar (TGB).

E. Provide a Telecommunications Bonding Backbone (TBB) consisting of a #6 AWG conductor in 0.75 inches schedule 40 PVC conduit from the MTGB to each TGB.

F. All grounding and bonding shall be in conformance with the National Electric Code and as recommended by EIA/TIA-607.

G. Bond all communications conduits, wireways, cable tray, conduit stubs and sleeves, etc. to the electrical / building grounding system. Ground cable tray to the ground bus and bond each joint with bonding jumpers for an absolute ground. All metallic conduit stubs to the cable tray for telephone, data, power or even empty conduits for future use shall be bonded to the cable tray to ensure ground continuity between the different raceway systems.

H. Provide means of bonding each joint for absolute grounding of the cable tray and ladder rack.
3.8 Cabinets  
A. Mount top of wall mounted cabinets 6 ft.-0 inches above floor. Coordinate location of recessed cabinets to be accessible and to avoid interference with other equipment and trades.  
B. Each cabinet shall be fitted with a full size 0.75 inches thick backboard for mounting terminal strips, equipment, etc.  

3.9 Identification / Labeling  
A. All continuous communications pathways such as conduit, cable tray, etc. shall be labeled to indicate origination and destination. Label shall be applied every 50 ft. wherever accessible or subject to administration. Coordinate label information with Owner.  
B. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned / prepped area of raceway.  

3.10 As-Built Documentation  
A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate “as-built” locations to show the actual route for the communications systems pathways.  
B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.  
C. Component Service Manuals: Include information for testing, repair, troubleshooting, assembly, disassembly, and required / recommended maintenance intervals for all types of pathways.  

3.11 Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means; refer to Raceway and Boxes for Electrical Systems Section 26 05 33 and Firestopping 26 05 05.  

END OF SECTION
PART 1 - GENERAL

1.1 This specification section covers common conduit systems, boxes, firestopping and sleeves. Where other methods are specified under separate sections for specific applications, the specific application requirements shall govern.

1.2 Refer to Section 26 05 05 Firestopping and Division 07 for firestopping requirements.

1.3 Refer to Section “Communication System Pathways and Support Equipment” for future communication system.

PART 2 - PRODUCTS

2.1 Conduit Type - Application (Use only conduit types listed)

A. Conduit - Rigid or Intermediate Grade Galvanized Threaded.
   Application - restrictions - (Not to be used in):
   1. Direct buried in corrosive soils.
   2. Corrosive atmospheres.

B. Conduit - Rigid Aluminum threaded.
   Application - restrictions - (Not to be used in):
   1. Underground.
   2. Corrosive atmospheres.
   3. In concrete.

C. Conduit - Thinwall EMT.
   Application - restrictions - (Not to be used in):
   1. Poured concrete.
   2. Exposed to weather.
   4. Exposed in mechanical equipment or other equipment/process rooms below 48 inches.
   5. Hazardous or corrosive atmospheres.
   6. Not to be used for medium voltage (2001 volts or higher) cable.
   7. Not to be used in utility tunnels.

D. Conduit - PVC Type 40 (Schedule 40) rigid, conforming to ANSI, NEMA specifications and each length UL labeled.
   Application - use limited to:
   1. In or under concrete slabs on grade where permitted by electric legend on the drawings.
   2. Exterior use when encased in 3 inch concrete.
   3. Direct buried, underground when indicated on drawings.
   4. Exterior use when encased in 3 inch concrete, for duct bank use only.

E. Conduit - Flexible Metal (Greenfield type), galvanized steel or aluminum.
   Application - use limited to:
   1. Connection to lighting fixtures; not over 6 ft. in length. Note: Metal-Clad Cable: Type MC may be used for fixture whips only; must contain green insulated ground conductor, be limited to 6 ft. in length and must use UL approved connectors.
2. Narrow movable partitions where other raceways are not practicable, when approved by the Architect or Engineer.
3. Connections to transformers, dynamic equipment and motors only in air streams or plenums.
4. In existing walls for remodel projects, vertical drops to outlets and switches; no more than 3 ft. out the top of the wall.

F. Conduit - Liquidtight Flexible Metal. 
Application - use and limitations:
1. Connections to all motors, except in air stream or plenum.
2. Connections to controls on dynamic equipment, transformers, etc., outdoors and indoors in wet locations.
3. Use not permitted underground or where subject to physical damage.

G. Plastic jacketed rigid steel conduit shall be ETL performance verified. Application – use in corrosive atmospheres including swimming pool areas, pool equipment rooms, chlorine storage areas, etc. and other areas as noted on the drawings.

H. Conduit Reinforced Thermosetting Resin RTRC shall meet UL 1684 for extinguishing flame and shall not contain any compounds that release halogens. 
Application use limited to:
1. In or under concrete slabs on grade where permitted by electric legend on drawings.
2. Exterior uses when encased in 3” concrete.
3. Direct buried, underground when indicated on drawings.
4. Exposed corrosive atmospheres including pool equipment rooms, chlorine storage areas, etc. and other areas as noted on drawings.
5. Where subject to physical damage shall be identified for use i.e., types RTRC-X W.

2.2 Conduit sizes
A. Conduits shall be 0.75 inch minimum size except 0.50 inch size may be used for switch legs and flexible connections to lighting fixtures.

2.3 Conduit Fittings
A. Fittings and workmanship shall ensure electrical continuity. All conduit systems in poured concrete shall be concrete tight.
B. Application of bushings, locknuts and insulated fittings shall comply with NEC requirements.
C. Use conduit fittings as manufactured by Efcor, Steel City, Raco, Midwest, Appleton, ETP / O-Z / Gedney, American Fitting Corporation or T&B, equal to the following catalog numbers:
1. Rigid and intermediate conduit
   • all fittings, couplings and connectors shall be threaded type.
   • grounding bushings, malleable iron; insulated; Steel City BG-801; Midwest Series GLL.
2. EMT
   • fittings shall be all steel, set screw or compression type, concrete tight.
   • set-screw type couplings; Midwest Series 460; Steel City TK 121; Appleton TW 50S.
   • compression type couplings; Midwest series 660S; Steel City TK111; Appleton TWC50CS.
   • set-screw type connectors; Midwest Series 450; Steel City TC 121; Appleton TWC 50S.
• compression type connectors; Midwest Series 650; Steel City TC111; Appleton TW50CS.

3. Flexible metal conduit
• malleable iron, "squeeze" type, non-insulated; Midwest series 1708; Steel City XC 901; Appleton 7481V. (For lighting fixture whips only - all steel or die cast screw in connector; Midwest 771; Steel City XC 241; Appleton SGC 50DC).

4. Liquid tight conduit
• steel or malleable iron; Midwest Series LT; Steel City LT 100; Appleton ST.

5. PVC Type 40 and Type TC-6
• couplings and fittings socket type solvent weld, coupling and solvent by same manufacturer as conduit.

6. RTRC
• Coupling and fittings socket type adhesive jointing. Coupling and adhesive by same manufacturer as conduit. Gasketed jointing system may be used underground where encased in conduit.

2.4 Boxes

A. Junction boxes and pull boxes shall be code gauge galvanized steel with multiple screw fasteners and galvanized steel covers.

B. Outlet boxes all steel construction with galvanized or plated finish or otherwise all metal, by Steel City, Appleton, Crouse Hinds, R&S or Raco.
   1. Lighting fixture outlet boxes 4 inches square or octagonal, 2.125 inches deep, with 0.375 inch fixture studs. Equal to Steel City Series 54171; Series 52171 with FE 421 stud. Fixtures weighing more than 50 lbs. shall be supported independently of the outlet box.
   2. Flush mounted device outlet boxes shall be minimum 4 inches square. Provide extension rings as required. Use Erico Caddy No. H2-3 mounting support plate where metal studs are used.
   3. Device rings in finished masonry or tile walls shall be square corner masonry type with no extended ears, to allow flush mounting of plates.
   4. Surface mounted device boxes shall be cast "FS" type or special surface mounted boxes for use with surface raceway systems.

C. Floor boxes shall be UL listed for its application as manufactured by Hubbell, Steel City, Walker, Raco or Wiremold. Drawings identify material type.

D. Provide water tight boxes, slip expansions and bonding jumpers where dictated by construction conditions.

E. Terminations at boxes shall be secured by locknuts or approved bushings.

2.5 Surface Metal Raceways

A. Snap on cover types by Mono-Systems, Panduit or Wiremold / Walkermold with prime gray finish (enamel finish coat to match room finishes in remodel areas). Application - permitted only when specifically shown on the drawings.
   1. Fittings, boxes and extension rings: Furnish manufacturer’s standard accessories; match finish of raceway.

2.6 Sleeves and Openings

A. Sleeves and formed openings shall be placed in walls, partitions, floor slabs and poured concrete roof decks for the passage of conduit, cable, wireway, cable tray and bus duct. Sleeves and formed openings are not required:
1. In floor slabs on grade.
2. Where conduit is installed before the wall, partition or slab is constructed.
3. Openings are cut for conduit passage and patched with equal or comparable material to close the space around the conduit.
4. In stud and gypsum board or plaster walls and partitions which are not fire rated.
5. For conduit passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions. Sleeves are required however, for which expansion, contraction and other movement can be expected.
6. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.
7. In large floor openings for multiple pipe and duct risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after conduits are set.
8. Sleeves for passage of conduit and cables shall be schedule 40 black steel pipe or galvanized rigid conduit. Rectangular sleeves for cables, wireway, cable tray and bus duct shall be 18 gauge galvanized steel in poured concrete floors, walls and roof decks; 26 gauge galvanized sheet steel in other than poured concrete.
9. Sleeves shall be sized to afford 0.25 inch to 0.75 inch clearance space.

2.7 In areas having special membrane waterproofing in or on the floor slab, a Josam 26420, or equal approved by the Architect, riser sleeve with clamping ring and auxiliary conduit sleeve extending 4 inches above finished floor or 8 inches above finished roof shall be used. Waterproofing membrane for roof and floor construction shall be secured by the clamping ring. These are to be used in areas having special membrane water-proofing in or on the floor slab and at roof decks.

2.8 Multiple conduits extending through the roof may be fitted with a manufactured pipe curb weatherproofing assembly equal to Pate # pca, lpca and m pca as an alternative to that specified in paragraph 2.7 above.

2.9 Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where conduits penetrate walls, floors, ceilings or overhead structure.

2.10 Anchors and Fasteners

A. Anchors and fasteners shall be of a type designed and intended for use in the base material to which the material support is to be attached and shall be capable of supporting the intended load and withstanding any associated stresses and vibrations.

B. In general, screws shall be used in wood, masonry anchors on concrete or brick, toggle bolts in hollow walls, and machine screws, bolts or welded studs on steel.

C. Nails shall not be used except for temporary support or for light loads in wood frame construction.

D. In outdoor locations or other corrosive atmospheres, the anchors and fasteners shall be non-corrosive or have suitable corrosion resisting coatings.

PART 3 - EXECUTION

3.1 Conduit shall be run concealed in all finished areas of new construction and elsewhere unless specifically indicated or upon specific permission by the Architect. All conduit shall parallel building lines.

3.2 All wiring and data cabling shall be run in conduit and shall be concealed. No cabling shall be run exposed.
3.3 Conduit shall be run overhead and shall not be run in or below concrete slabs unless specifically indicated on the drawings and in the legend on the drawings.

3.4 Where feeders are permitted to be run below floor slab on grade, they shall be installed in non-metallic conduit encased in 3 inch concrete using galvanized rigid steel or RTRC (equal to Champion Fiberglass) elbows with all necessary fittings and couplers. (NOTE: Where not required to be run overhead, branch circuits may be installed in 1 inch or smaller Schedule 40 PVC conduit below the vapor barrier, shall have a minimum of 6-inch fill over the conduit below the vapor barrier without concrete encasing the PVC. The 90 degree elbow and stub up shall be galvanized rigid steel).

3.5 Branch circuits are permitted to be run under the floor slab in PVC conduit. All conduits installed below concrete slab on grade shall have a minimum of 6-inches fill over the conduits in order to prevent accidental damage to conduits should the floor be saw-cut in the future. Stub ups and 90 degree elbows shall be rigid conduit.

3.6 All conduits installed below concrete slab on grade shall have a minimum of 6-inches fill over the conduits in order to prevent accidental damage to conduits should the floor be saw-cut in the future.

3.7 Conduits shall not be installed above the vapor barrier in concrete floors poured on grade.

3.8 Conduit crossing building expansion joints shall have expansion provisions with grounding continuity; use special expansion fittings or other NEC approved method. Refer to the Architectural and Structural floor plans and details for locations of expansion joints.

3.9 Do not install wall-mounted boxes back-to-back in opposite sides of wall; in stud walls, boxes shall be on opposite side of studs. In acoustic rated and fire rated walls boxes shall be separated a minimum of 24 inches.

3.10 Boxes not otherwise accessible in ceilings and walls shall be made accessible by installation of hinged door access panels. Refer to Section 26 05 04 - Basic Electrical Materials and Methods.

3.11 Use cast floor boxes for installation in slab on grade; formed steel boxes are acceptable for other installations.

3.12 Work shall be so planned as to:

A. Minimize the number of offsets and junction boxes. For feeder conduits, use all long radius conduit bends or accessibly located large junction boxes with screw covers.

B. Generally run conduit and conductors as high as practicable against underside of floor slab in concrete construction or immediately below the top chord of bar joist construction unless otherwise shown. This high level zone shall be used for running electrical raceways. Running conduits promiscuously at various levels and directions will not be acceptable. Runs at bottom chord level or ceiling grid level will not be acceptable.

C. Where spray on fireproofing is used, coordinate with the General Contractor about installing supports, panel feeders and larger conduits before fireproofing is applied. Branch circuit conduits and smaller size conduits may be run as high as possible on stud walls that go all the way up to the structure; this will minimize damage to spray on fireproofing. Patch and repair damaged spray on fireproofing caused by electrical installation; conduits shall not be fully covered with fireproofing.

D. Coordinate activity in advance to avoid interference with other trades.

E. Provide access to all junction and pull boxes.
F. Maintain 6 inches from conduit to paralleled hot water piping and 4 inches from cross piping and 12 inches from generator exhaust piping.

3.13 Secure feeder conduit to basic structural elements with galvanized strap hangers and clamps; use of trapeze type hangers is encouraged for multiple conduits where space will permit. Galvanized metal clamps and screws may be used for attaching and supporting branch circuit conduit. Non-metallic fasteners shall not be used except plastic inserts may be used in concrete for small conduits. Vertical conduits shall be supported at each floor by clamps.

3.14 Surface mounted horizontal and vertical conduit supports on walls up to a height of 7 feet-0 inches above the floor shall be one or two hole sheet metal pipe straps. Pinch type hangers similar to Minerallac type may only be used at heights greater than 8 feet-0 inches. The use of pinch type hangers similar to Minerallac type are expressly prohibited on ductwork, air handling units and other mechanical equipment below 8 feet-0 inches.

3.15 During construction temporarily cap open ends of conduit. Caution trades to take special care of runs in concrete slabs during pouring.

3.16 Empty conduit installed for communications use or for future systems shall have an insulated pull wire or heavy nylon cord inserted for use in pulling wires.

3.17 Pull mandrel or large swab thru conduit to ensure freedom from debris before pulling wires. Use pulling lubricants sparingly.

3.18 Sleeves for passage of conduit, cables, wireway, cable tray and bus duct shall be placed in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect.

3.19 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.20 Refer to 26 05 05 Firestopping. Sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.21 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the conduit, cable, cable tray, bus duct and raceway shall be closed with caulking to retard the passage of smoke.

3.22 Where permitted by OBC Section 712 Penetrations, metallic conduits requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls and partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar).

3.23 Openings for multiple conduits extending through floors where water protection is required (mechanical rooms, kitchens, other potentially wet areas) may be protected with a 4 inch high by 4 inch wide concrete curb with chamfered corners in lieu of individual sleeves. These concrete curbs may be used in lieu of the Josam 26420 riser sleeve and clamping ring provided the floor membrane and curbing are arranged to maintain the integrity of the membrane.

3.24 Conduits, wire and cables entering from outside the building shall be sealed water and moisture tight. Seal between conduit and sleeves, conduits and core drilled holes and around conductors inside conduits. Provide cast iron pipe or schedule 40 galvanized steel conduit sleeves in exterior walls below grade, with intermediate wall stop and anchor collar set in place before concrete
pouring. Sleeve shall be a part of the sealing assembly. When the wall opening is core drilled the wall sleeve may be omitted. A mechanically compressed rubber sealing assembly equal to Thunderline Corp. "Link-Seal" shall be placed in the annular space between conduit and sleeve or core drilling.

3.25 Conduits extending through the roof shall be made watertight by means compatible with the roofing system and as directed by the Roofing Contractor (the company who presently holds the warranty on the roof) and approved by the Architect.

3.26 Power actuated fasteners of any type are prohibited in occupied buildings. This includes anchors which are driven into place by any device which produces an impact force by use of a powder charge, compressed air, gas or any other propellant.

3.27 Provide four (4) 1 inch diameter spare conduits for each flush mounted branch circuit panelboard; extend from top of panelboard to above an accessible ceiling for future use.

3.28 All conduit terminations to be equipped with locknuts and bushings. Conduits 1-1/2 inches and larger shall have insulating bushings, grounding lug and shall have locknuts inside and outside the enclosure.

3.29 Outlet Box Installation
   A. Set box square and true with finished building surfaces and trim.
   B. Secure boxes firmly to building structure.
   C. Verify location of outlets and switches in finished rooms with Architectural Drawings of interior details and finish. In centering outlets and locating boxes, allow for overhead pipes, ducts and mechanical equipment, variations in fireproofing and plastering, window and like, and correct any inaccuracy from failure to do so without expense to the Owner.
   D. Maintain symmetry of all outlets as closely as possible contained within Architectural Elevation. For example, the Contractor shall center light fixture over doorway or receptacle in section of masonry wall, if shown in that approximate position. If receptacle is shown in same location as counter or bench, determine countertop height and set receptacle to clear top and trim of counter and render outlet easily accessible.
   E. In the event of conflict between locations of electrical outlets as shown on the Electrical Drawings and on the Architectural Drawings, outlets shall be installed in accordance with the latter.
   F. Locate light switches on latch side of door and verify door hinge location in field prior to switch outlet installation.
   G. The Owner reserves the right to relocate any device as much as 10 feet-0 inches (measured horizontally) from its indicated location at no additional cost, provided the contractor is notified prior to roughing that device in.

3.30 Contractor shall record carefully on a set of "as built" prints the exact location of all feeder conduits.

3.31 Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only - ground conductors are not counted when determining maximum fill for this purpose.

END OF SECTION
PART 1 - GENERAL

1.1 Equipment Identification

A. Identify all the following items with laminated plates:
   1. Switchboards, including all subassembly switches.
   2. Every motor, lighting and equipment controller and disconnect switch.
   3. Panelboards.
   4. Motor controllers and individual motor starters within panelboards.

B. Nameplate on motor controllers, disconnect switches, automatic transfer switches, switchgear, switchboards, panelboards and transformers shall indicate source, voltage disconnect location, and load served.

C. Equipment on the emergency systems shall be identified with nameplates having a red background. Outlets on the emergency systems shall be identified red. This shall be accomplished by using red devices or by providing a coverplate with "EMERGENCY" engraved on the face; fill engraving with red paint or equal.

D. Branch circuit panelboards:
   1. Identify panel designation on directory card within the panel.
   2. Fill out branch circuit directory indicating circuit number and area served, rooms, group of rooms, lighting, convenience outlets, motors, etc. Card index shall be neatly typed.
   3. Update or replace branch circuit directory in existing panelboards in areas of alteration.
   4. Branch circuit phase conductor color format shall be permanently identified inside each panelboard.

E. Conduit and junction boxes:
   1. Color code or label all junction boxes and exposed conduit at 20 ft. intervals. Coding shall be painted or labels of the pre manufactured type permanently mounted with metal or plastic band.
   2. Provide a color identification scheme under heavy plastic cover hanging in the electrical rooms; identification shall be:
      a. Emergency - Orange
      b. Normal - Black
      c. Fire Alarm - Red
      d. Sound - Blue
      e. Telephone - Yellow

F. Wire identification:
   1. Identify communications and signaling system wiring and branch circuit wiring by circuit number in panels and motor control center wiring gutters by means of permanent durable wire markers wrapped around or fastened to conductors. This shall be done concurrently with pulling of conductors.
   2. Wiring or fiber cabling installed by Contractor for termination by Owner's vendor such as for telephone or data systems shall be identified at both ends utilizing the alpha/numerical identification schedule established by the system vendor.

2.1 Nameplates

A. Nameplates shall be laminated phenolic with black surface (red surface for emergency) and white core. Use 0.0625 inch thick material for plates up to 2 inches x 4 inches and 0.125 inch...
thick for larger sizes. The lettering shall be Condensed Gothic with space between the lines equal to the width of the letters. Use 0.25 inch minimum height letters on the small plates increasing the size proportionately to plate size.

B. The lettering on the plate shall indicate the name of equipment, the specific unit number, voltage, phases, which panel, switchboard or motor control center the equipment is served from, and any other reference data pertinent to the operation. Names and numbers shall coincide with those listed on the drawings. Sample: Panel 3A; 277/480 V, 3 phase, 4 wire, served from unit substation USI.

PART 2 - EXECUTION

3.1 Nameplates shall be secured with screws, one on each end.

END OF SECTION
PART 1 - GENERAL

1.1 Specific wiring applications are identified. Refer to applicable sections of the specifications.

PART 2 - PRODUCTS

2.1 Materials and equipment shall be as indicated on the drawings and in the specifications.

PART 3 - EXECUTION

3.1 Final connections to fixture pigtails shall be made with approved pressure connectors such as 3M "Scotchlok".

3.2 Miscellaneous Equipment Connections

A. Various items of equipment such as kitchen, shop equipment, etc. will be furnished and set in place by other trades. This equipment, unless otherwise shown on the drawings, will be furnished with necessary electrical outlets, operating and control switches, terminating in an electrical outlet box, or equivalent electrical connector located on the equipment. This Contractor shall furnish power wiring to these various items of equipment and connect them up complete and ready for operation.

B. Where disconnect switches are indicated or where otherwise required, these shall be mounted in an accessible location; but in the case of laboratories, kitchens and finished areas, in an inconspicuous a place as possible. Under counter installation of disconnect switches is preferred to locations above the counter, however, care shall be taken that such switches will be accessible and do not interfere with installation of the equipment.

C. Roughing in drawings for equipment shall be obtained from the Architect as the time approaches when such equipment is required. (Allow a reasonable period from the time of notice to secure this information.)

3.3 Miscellaneous Wiring and Interlocks

A. Various items of work in connection with interlocking motor and starter operations and providing wiring to serve equipment which is furnished by other trades.

B. Interlocks between motor controllers for purposes of accomplishing sequence control or simultaneous operation of motors are all to be included by the Contractor. Requirements for a simple simultaneous motor operation interlock are indicated by a schedule on the drawings. These interlocks consist of auxiliary contacts on the starter of the lead motor wired in, according to standard diagrams of the motor starter manufacturer to energize the holding coil of the starter for the motor. These interlocks shall be thru the "automatic" position only of the starter where HOA switches are supplied. Where interlocks, other than the simple sequence above are required, these shall be as described hereinafter. This Contractor shall inquire of the Engineer during bidding, or at the earliest practical date, regarding any questions which may arise regarding the intention and scope of this work. This Contractor shall furnish extra contacts for his starters where required, in lieu of which he may furnish externally mounted relays to accomplish the specified function.

C. Air handling unit motors shall lead and exhaust fans and moving media air filters follow. Chiller pumps shall lead, followed by chiller, condenser pump and cooling tower, in that order. Condenser pumps shall lead and chemical feeder shall follow. Hot water pumps shall lead and boilers follow.
D. The following is a list of equipment and systems requiring wiring. Note that these are in addition to standard interlocks which are scheduled on the drawings.

1. Refer to the Fire Alarm Specification 28 31 00 for Smoke Damper Operation Requirements.
2. Exterior lighting control shall consist of a combination multiple circuit timer and photoelectric cell system furnished by this Contractor. Refer to notes and details on drawings for further information.
3. Motorized Doors - Door controls, including relays, operating switches, limit switches and wiring diagrams, will be furnished by the door equipment supplier. These shall be received by the Contractor and installed complete and ready for use, in accordance with approved wiring diagrams. Where motorized doors are located in fire walls and smoke partitions, provide a signal from the fire alarm system to disable the door controls and allow it to be manually operable while maintaining its latching feature.
4. Motorized backdraft dampers on exhaust fans and power roof ventilators shall be connected up to their respective associated motor leads to energize the backdraft damper motor and open the damper when the fan operates. Dampers, operator and transformer if required, will be furnished by the fan supplier. Where the motors are fed from a variable frequency drive controller (VFD) provide a separate branch circuit to serve the dampers from the nearest panelboard (normal or emergency use same type of source as the associated fan motor) with control through the VFD damper control output relay. Coordinate requirements with the VFD Supplier.
5. Independently mounted controllers, furnished by others: where starters are furnished by other trades, and are required to be mounted remote from the motor, this Contractor shall accept and mount them and perform all power and control wiring between controls and motors as indicated. Motor controllers equipped with automatic alternators shall have two independent circuits and control sources to preclude loss of operation when one circuit fails.

END OF SECTION
PART 1 - GENERAL

1.1 Scope

A. Provide a protective device coordination study for the new electrical distribution system provided by this project and those portions of the existing electrical power distribution system affected by this project. It is not intended that the entire existing building be included in the study.

B. The study shall include a short-circuit study and equipment-interrupting or withstand evaluation on all portions of the electrical distribution system from the normal sources of power through the low-voltage distribution systems to the branch circuit panelboard level. All modes of operation shall be thoroughly covered in the study.

1.2 References

A. Institute of Electrical and Electronics Engineers,
   2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   3. IEEE 399 – Recommended Practice for Power Systems Analysis
   4. IEEE 551 – Calculating Short Circuit Currents in Industrial and Commercial Power Systems
   5. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. National Fire Protection Association,
   1. NFPA 70 – National Electrical Code
   2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.3 Qualifications

A. The short-circuit, protective device coordination and arc flash analysis studies shall be conducted under the supervision and approval of a Registered Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical engineer shall be a full-time employee of the Engineering Services Company.

B. Submit qualifications and background of firm. Submit qualifications of Professional Engineer performing the study.

1.4 Submittals

A. The short circuit and protection device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient data to ensure that the selection of device and characteristics will be satisfactory.

B. The results of the short-circuit, protection device and arc flash hazard analysis studies shall be summarized in a final report. Three (3) bound copies of the complete report shall be submitted for owner reference. A disc copy of final analysis shall also be provided.

PART 2 - PRODUCT
2.1 Studies

A. The Contractor is to furnish short-circuit and protective device coordination studies as prepared by the equipment manufacturer(s) or Engineering Services Company.

B. The coordination study shall be from the utility company’s protective device and include all of the electrical protection devices down to and include the largest feeder breaker and motor starter in the motor control center, equipment control panels and power distribution panels, the stepdown transformer and branch panelboards.

2.2 Data Collection

A. The Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit and coordination studies and flash analysis shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to ensure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized shall include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. Include fault contribution of existing motors in the study, with motors <50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 Short-Circuit And Protective Device Evaluation Study


B. Transformer design impedances and standard X/R ratios shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system, generation system and motor fault contribution characteristics
5. Typical calculations
   a. Fault Impedance
   b. X to R ratios
   c. Asymmetry factors
   d. Motor fault contributors
   e. Short circuit kVA
   f. Symmetrical and Asymmetrical phase-to-phase and phase-to-ground fault currents
   g. Tabulation of calculated quantities and results
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility’s supply point
2. Incoming switchgear and switchboard
3. Branch circuit panelboards
4. Equipment control panels
5. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings
   2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
   3. Adequacy of transformer windings to withstand short-circuit stresses
   4. Cable and busway sizes for ability to withstand short-circuit heating
   5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.4 Protective Device Coordination Study

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:
   1. Electric utility's protective device
   2. Medium voltage equipment relays
   3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
   4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
   5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
   6. Conductor damage curves
   7. Ground fault protective devices, as applicable
   8. Pertinent motor starting characteristics and motor damage points
   9. Pertinent generator short-circuit decrement curve and generator damage point
   10. Equipment control panels.
   11. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 Arc Flash Hazard Analysis

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2015, Annex D.
B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and equipment control panels) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all MV, 480V locations and significant locations in 240V and 208V systems fed from transformers equal to or greater than 45 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.6 Report Sections

A. Input Data:
   1. Short-circuit reactance of rotating machines with associated X/R ratios
   2. Conductor type, construction, size, # per phase, length, impedance and conduit type
   3. Bus duct type, size, length and impedance
   4. Transformers
   5. Reactor impedance and continuous ampere rating
   6. Aerial line type, construction, conductor spacing, size, # per phase and length
   7. Circuit resistance and reactive values

B. Short-Circuit Data:
   1. Utility three-phase and line-to-ground available contributor with associated x/R ratios
   2. Source fault impedance and generator contributions
   3. X to R ratios
   4. Asymmetry factors
   5. Motor contributions
   6. Short circuit kVA
   7. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings
   1. Phase and Ground Relays:
      a. Current transformer ratio
      b. Current setting
      c. Time setting
      d. Instantaneous setting
      e. Specialty non-overcurrent device settings
      f. Recommendations on improved relaying systems, if applicable
   2. Circuit Breakers:
a. Adjustable pickups and time delays (long time, short time, ground)
b. Adjustable time-current characteristic
c. Adjustable instantaneous pickup
d. Recommendations on improved trip systems, if applicable

D. Incident Energy and Flash Protection Boundary Calculations

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard risk category
8. Recommendation for arc flash energy reduction

PART 3 - EXECUTION

3.1 Field Adjustment

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the startup and acceptance testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify owner in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.2 Arc Flash Warning Labels

A. The vendor shall provide a 3.5 in. X 5 in. Thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have a header with the wording, orange header - “Warning, Arc Flash Hazard” or red header - “Danger Arc Flash Hazard”, and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings.

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects and equipment control panel, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided on each side in door/panel.
3. For each low voltage switchboard, one arc flash label shall be provided on each front and rear door.
4. For each switchgear, one flash label shall be provided on each front and rear panel.
5. For medium voltage switches one arc flash label on each front and rear door shall be provided.

E. Labels shall be field installed by the Engineering Service Division of the equipment manufacturer or the Engineering Service company.

END OF SECTION
PART 1 - GENERAL

1.1 Lighting control devices are identified on the drawings per legend symbols or as specifically noted. Catalog numbers from acceptable manufacturers for the common wiring devices shall be as listed herein. Catalog numbers are not listed for all devices. Other devices, such as key switches, clock hanger outlets, etc. shall be furnished by one of the manufacturers listed and shall be equal in quality to the device series listed.

1.2 When shop drawings are required for wiring devices the submittal shall be comprehensive for all wiring device configurations listed in the legend and for devices specifically noted on the drawings, including wall box dimmers, occupancy sensors and load control relays.

PART 2 - PRODUCTS

2.1 Toggle type AC switches shall be listed by Underwriters Laboratories, Inc. Switches shall be 20 ampere, 120/277 volt AC and ivory (select color) in color unless noted otherwise.

<table>
<thead>
<tr>
<th>Acceptable Manufacturer</th>
<th>General Purpose</th>
<th>Red Pilot</th>
<th>Illuminated</th>
<th>Lighted Handle</th>
<th>Momentary</th>
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<td>AH1221 LT series</td>
<td>1995 series</td>
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<tr>
<td>P&amp;S</td>
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<td>PS20AC2 RPL series</td>
<td>20AC1 SL series</td>
<td>1251 series</td>
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2.2 Ceiling Mount Occupancy Sensor

A. Sensor shall be dual technology to detect human presence in controlled area by ultrasound and passive infrared. Dual sensing with both technologies must occur to activate lighting system. Sensor to be fully adaptive with self-adjusting and self-calibration.

B. Sensor shall have signal processing to respond to only those signals caused by human motion. Sensor to operate instantly for room motion and time off delay adjustable for 5 – 30 minutes. Sensor to be equipped with a walk-thru mode.

C. Sensor area coverage to be minimum of 1000 SF for one sensor. Provide multiple sensors where needed for space coverage.

D. Sensor shall have provisions for manual-off function for lighting circuit from remote momentary switch (reset when not occupied) or maintained (off override).

E. Provide an additional single-pole, double throw isolated contact with each power pack for remote interface.

F. Integral photosensor for delaying turn-on of fixtures when sufficient light available in the space. Provide in ceiling mounted sensor where noted on drawings.

G. Power pack for remote mounting to match occupancy sensor.

H. Verify color with Architect.

I. All components to have 5-year warranty.
J. Manufactured by Watt-Stopper, Greengate (Cooper Controls), Hubbell Control Solutions, Leviton, Sensor Switch or Lutron.

2.3 Electronic Low Voltage (0 – 10V) Dimmer

A. General Requirements

1. Utilize air gap off, activated when user selects "off" to disconnect the load from line supply.
2. Operates at the rated capacity across the full ambient temperature range including modified capacities for ganged configurations which require removal of fins.
3. Provide radio frequency interference suppression.
4. Surge Tolerance: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
5. Dimmers: Provide full range, continuously variable control of light intensity.
6. Dimmers for Electronic Low Voltage (ELV) Transformers:
   a. Provide circuitry designed to control the input of electronic (solid-state) low voltage (ELV) transformers. Do not use dimmers that utilize standard phase control.
   b. Provide resettable overload protection that provides automatic shut-off when dimmer capacity is exceeded. Do not use protection methods that are non-resettable or require device to be removed from outlet box.
   c. Designed to withstand a short, per UL 1472, between load hot and either neutral or ground without damage to dimmer.
7. Fluorescent Dimmers:
   a. Provides direct control of fluorescent dimming ballasts up to the ballast manufacturer's specified rating.

B. Preset Smart Wall Dimmers and Switches:

1. Dimmer Control: Multi-function tap switch with raised rocker for dimmer adjustment.
   a. Rocker raises/lowers light level, with new level becoming the current preset level.
   b. Switch single tap raises lights to preset level or fades lights to off.
   c. Switch double tap raises light to full on level.
   d. Switch tap and hold slowly fades lights to off over an extended period.
   e. LEDs adjacent to tap switch indicate light level when dimmer is on, and function as locator light when dimmer is off.
   f. Preset Smart Dimmer: 3-wire fluorescent ballast/LED driver (6 A, 120 V); multi-location capability using companion dimmers (up to nine companion dimmers may be connected); minimum load requirement.
   g. Companion Dimmer: Provides multi-location capability for compatible dimmers.

C. Dimmer shall be rated for the wattage it is supplying. Contractor shall coordinate lighting load on each respective dimmer and provide properly rated dimmer accordingly (600w to 1000w).

D. Contractor is responsible to coordinate the dimmer with each lighting manufacturer and verify that dimmer is compatible and capable of controlling lighting loads/fixtures from fixture manufacturer being supplied on the job.

E. Verify color of dimmer with architect prior to ordering.

F. Dimmer shall control loads down to 10%.

G. 0-10v electronic digital dimmer shall be Lutron Maestro Series, Leviton Decora, Crestron Cameo, Cooper Decorator, Watt Stopper Miro, or approved equal.

2.4 Provide a device plate to suit each particular application. Cover all empty outlet boxes with a blank plate. Coverplates shall be manufactured by Pass and Seymour, Hubbell, Cooper, Bryant, Leviton
or Mulberry; Taymac is an acceptable manufacturer for weatherproof non-metallic coverplates Multi-Mac Series, “While-In-Use” type, 3.5 inches depth, opaque grey, locking tab marked “EXTRA Duty”.

2.5 In finished spaces, wall plates shall be nominal .032 inch thick, made of 302 high nickel stainless steel with brushed satin finish and beveled edges. Screws shall be metal with countersunk heads and finished to match plates. Sectional plates will not be permitted.

2.6 Installations consisting of three or more wall switches or wall box dimmers mounted together with either separate coverplates or a common coverplate shall have each coverplate engraved so as to identify the circuits or fixtures being controlled by each switch or dimmer. Refer to the drawings for special instructions.

PART 3 - EXECUTION

3.1 Locate devices as shown on the drawings, coordinate exact location with other trades, to avoid interference. Check for potential interference from door swings, cabinets, HVAC equipment and other wall mounted devices.

3.2 Clean debris from device boxes prior to installation of devices. Adjust devices and coverplates to be flush and level.

3.3 Occupancy Sensor Installation

A. Verify location of occupancy sensor(s) with selected manufacturer prior to rough-in to minimize false activation of the device. Locate sensor and adjust activation field to avoid nuisance activation by movement outside of the controlled space. Sensors shall sense any human motion in the space and allow turn on with entrance into the space.

B. Provide all material and labor for a complete and operational system including power and slave packs, auxiliary relay modules and backboxes. Verify application voltage rating and provide proper rated devices.

C. Low voltage wiring can be open wired above accessible ceilings, utilize plenum rated cabling. Installation in exposed or inaccessible locations shall be installed in conduit.

D. Coordinate time delay off setting of each occupancy sensor with the Owner. Maximum time delay off shall be 30 minutes. Minimum off delay is 10 minutes for intermittent use spaces.

E. Maintain 6 feet (minimum) to 8 ft. distance from an HVAC air outlet.

3.4 Functional Testing – Lighting control devices and control system shall be tested to ensure the control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer’s installation instructions.

A. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.

B. Confirm that the placement, sensitivity and adjustments of daylight sensors yield acceptable performance.

C. Testing shall be performed by equipment supplier. Provide report to Engineer.

END OF SECTION
PART 1 - GENERAL

1.1 Each panelboard shall comply with all applicable codes, recommended practices and standards of IEEE, NEMA and UL. Panelboard shall be UL labeled.

1.2 The panelboard manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and the fuse/circuit breaker combinations indicated on the drawings.

PART 2 - PRODUCTS

2.1 Panelboard Types

A. 240 Volt (Maximum) AC Panelboards

1. Breakers shall be “bolt-on” type and in sizes thru 100 amp shall be minimum 10,000 amp, I.C. rated with adequate rating to interrupt the available fault current, for a fully rated system.
2. GFCI breaker – UL Class A (5 milliampere sensitivity, combination type). Ground fault circuit protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection. Space required in panelboard shall be same as standard single pole circuit breaker.

B. Circuit Breaker Distribution Panelboard

1. Removable front with hinged door. Bussing braced for the available fault current; 1200 amp bussing and less.
2. Main breakers shall be solid state electronic trip molded case type with adjustable long time, short time, instantaneous trip. Feeder breakers shall be molded case type, thermal-magnetic protection, 80 percent rated.
3. Power and distribution panelboards by Square D “I-Line”, Siemens “Sentron” or equivalent by Eaton or G.E.
4. Provide integral metering and SPD as shown on the drawings. One digital power meter with current (each phase), voltage (phase to neutral and phase to phase), power factor, THD, instantaneous, minimum, maximum, kWh, and 15-minute kWD demand readings, with local digital display. Digital power meter utilizes standard CT’s with 5A secondaries. Metering voltage input may be direct (no PT’s required) up to 600 VAC, or standard switchgear style PT’s up to 1.7 MV. Square D model PM820 with local display or equal by Eaton, Siemens, G.E. or Electro Industries.

2.2 Refer to “Identification for Electrical System” Section 26 05 53, for nameplate requirements.

2.3 Refer to Section 26 24 17 “Panelboard with Surge Protective Device” for panelboards with surge suppression and filter system built into panelboard enclosure.

2.4 General Construction

A. Code gauge, galvanized steel tubs with minimum 4 inches clear gutters all sides. Minimum tub width 20 inches, depth 5 inches.

B. Locking type reinforced doors with concealed hinges; equipped with directory card holder on inside of door; enameled finish. Doors over 48 inches high shall have 3 point latch and vault locks. All locks shall be master keyed cylinder, keyed alike.
C. Permanent individual breaker pole numbers affixed adjacent to each breaker in a uniform position consisting of a stamped metallic or painted numeral.

D. Bussing shall be copper.

E. Branch circuit panelboard tubs and fronts shall be sized to have 225 amp bussing and accommodate 42 poles unless indicated otherwise on the drawings. Furnish number of breakers shown.

F. A neutral bar assembly (when required) and separate ground bar assembly shall be provided. Each assembly shall be copper and have the adequate number of terminals, of sufficient size and type of anti-turn solderless lugs. Each assembly shall have conductor terminal screwdriver slots facing the front of the panel. Bond ground bar assembly to panel cabinet.

G. Terminals for feeder conductors to the panelboard mains, neutral, ground and branch circuit breaker wiring shall be suitable for the type of conductor specified.

H. Main or sub-feed breakers shall be provided where indicated. Shunt trip breakers where specified, shall have 120 volt coil and coil clearing contacts.

I. Where main or sub-feed contactors are indicated, they shall be ASCO Bulletin #920-114 or Square D Type "PB" electrically operated, mechanically held contactor. The operating coil shall be 120 volt with 2-wire control. Provide a separate hinged door and lock matching panel lock, for main and sub-feed contactors.

J. Circuit breakers shall be thermo magnetic, bolted type and where more than one pole is used, they shall employ a common trip.

K. Breakers in panelboards used for switching of 120 and 277V. fluorescent lighting circuits shall be rated for switching duty UL "SWD" or "HID" type; for switching high-intensity discharge lighting shall be “HID” type.

L. Breakers used for protection of heating, air conditioning and refrigeration equipment shall be UL "HACR" type.

2.5 The panelboards and breakers shall be adequately rated for the available fault current as indicated on the drawings and in the specifications. The total breaker and fuse short circuit and overcurrent protective system shall be U.L. Fully Rated System.

PART 3 - EXECUTION

3.1 Mount top of wall mounted cabinets 6 feet 0 inches above floor. Coordinate location of recessed panels so they are accessible and to avoid interference with other equipment and trades. Mount and anchor floor set panelboards on a 4 inch high concrete pad furnished by this Contractor.

3.2 The position of breakers in each panel shall be arranged in the field for sequence phasing by this Contractor to best suit wiring conditions and balancing of phases. Fill in, typewritten, the directory of each branch circuit panelboard.

3.3 For multi-wire branch circuit group circuit breaker together and provide breaker handle tie. Group conductors together with tie-wrap.

END OF SECTION
PART 1 - GENERAL

1.1 Work includes all special cabinets and enclosures; equipment shall conform to requirements of N.E.C. and shall be UL labeled.

PART 2 - PRODUCTS

2.1 Telephone Miscellaneous Cabinets

A. Indoor cabinets shall match panelboard finish and construction and shall be manufactured by Siemens, Square D, Eaton, Tanco Inc., Park-Ohio or G.E.

B. Outdoor enclosures shall be manufactured by Hoffman, Rittal Corp., Milbank, Tanco Inc. or Hennessy Products.

C. Provide backboard for mounting equipment, ¾ inch plywood. Paint matte white.

2.2 Indoor Cabinets - NEMA 1

A. Cabinets shall be galvanized code gauge steel, finished gray enamel or manufacturer's standard equivalent finish, of sizes shown with flush painted hinged door and master keyed cylinder locks keyed to match panelboard locks. Cabinets in finished areas shall be designed for flush mounting with separable front overlapping flange. Cabinets in concealed areas shall be surface mounted types.

B. Each cabinet shall be equipped with a 0.75 inch thick waterproof fir plywood backboard painted gray.

2.3 Outdoor Enclosure - Single Door - Small

A. The enclosure shall meet or exceed the requirements of a NEMA 3R rating and shall be UL listed.

B. The cabinet and door shall be constructed from 5052-H32 sheet aluminum alloy; 0.125 inch thick. The door opening shall be double flanged on all four sides.

C. The cabinet door shall be a minimum of 80 percent of the front surface area and shall be gasketed (UL 508 table 21.1) with weather tight seal between the cabinet and door.

D. The hinges shall be continuous and made of 0.063 inch stainless steel with 0.120 inch diameter stainless steel hinge pins.

E. The latching mechanism shall be a slam type with Corbin #R357SGS, or equal lock with keyhole cover for NEMA 3R enclosure; for NEMA Type 4X enclosure, the latch shall be weather tight quarter turn type. Furnish 2 keys with each lock.

F. Provide aluminum back panel or two adjustable "C" mounting channels with infinite vertical and horizontal adjustment complete with all mounting hardware.

G. Cabinet finish shall be natural aluminum finish or factory painted using the three step iron phosphate conversion technique verify finish with architect prior to ordering and provide accordingly.

H. Cabinet mounting plates shall be located at bottom and top of enclosure for either in wall mounting or surface mounting.
I. Provisions shall be included for pad-mounting.

PART 3 - EXECUTION

3.1 Mount the cabinets and enclosures as indicated on the drawings and in accordance with manufacturer's instructions.

3.2 Mount top of wall mounted cabinets 6 feet-0 inches above floor. Coordinate location of recessed cabinets so they are accessible and to avoid interference with other equipment and trades.

3.3 Mount and anchor floor set enclosures on a concrete pad furnished by this Contractor. Indoor pads shall be 4 inches high; outdoor pads shall be steel reinforced as indicated on the drawings.

3.4 Provide the concrete base for the pad-mount transformer and secondary enclosure. Pad shall be minimum 10 inches thick, 4000 pound test concrete with #4 rebar 12 inches on center each way in center of pour. Pad shall extend 6 inches past enclosure on all four sides with chamfered edges. Form sleeves in pads for conduit entry and place conduits prior to pouring. Pad shall be 3 inches above and 7 inches into finished grade. Over excavate and provide a 12 inch thick compacted pea gravel sub-base below pad.

3.5 Refer to "Identification for Electrical System" Section for nameplate requirements.

END OF SECTION
PART 1 - GENERAL

1.1 Wiring devices are identified on the drawings per legend symbols or as specifically noted. Receptacles are identified in the legend by NEMA configuration numbers only. Catalog numbers from acceptable manufacturers for the common wiring devices shall be as listed herein. Catalog numbers are not listed for all devices. Other devices, such as clock hanger outlets, etc. shall be furnished by one of the manufacturers listed and shall be equal in quality to the device series listed.

1.2 When shop drawings are required for wiring devices and coverplates, the submittal shall be comprehensive for all wiring device configurations listed in the legend and for devices specifically noted on the drawings.

PART 2 - PRODUCTS

2.1 Extra hard use specification grade receptacles shall be listed by Underwriters Laboratories, Inc. Receptacles shall be minimum 20 ampere, 125 volt, NEMA configuration 5 20R and ivory (select color based on architect’s selection during shop drawing submittals)

<table>
<thead>
<tr>
<th>Manfacturer</th>
<th>Single</th>
<th>Duplex</th>
<th>Ground</th>
<th>WR</th>
<th>Isolated</th>
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2.2 Receptacles installed in a damp or wet location shall be a listed weather-resistant (WR) type.

A. Receptacle shall be installed in a listed weatherproof enclosure, whether or not the attachable plug cap is inserted.

2.3 Provide GFCI devices as shown on drawings and in compliance with NEC 210.8 for type and location.

2.4 Where GFCI receptacle devices are not available at rating required for GFCI protection device/circuit to be provided with Bender Lifeguard devices for GFCI protection.

2.5 Isolated ground devices shall be orange in color.

2.6 Transient voltage surge suppressors (SPD-ANSI/IEEE Category A and B), UL 1449 suppression (clamping) rating of 400 V, 3 mode protection (LN/LG/NG) for 120 V branch circuits:

A. Duplex receptacles, 120 V, 20 A shall be LeGrand 5362-ISP, Hubbell HBL5362ISA, Leviton 5380-I, Bryant SP53-TIGIA or Eaton 5350S. Receptacle to be listed UL 1449 Type 3.

B. Suppression strip with a heavy duty 6 ft. 14-2 AWG power cord, 6 electrical NEMA 5-15R 120V, 15 A outlets, computer grade on/off 20 A switch, resettable circuit breakers, internal thermal fusing, hybrid suppression circuit and comprehensive diagnostics. Strip to be listed UL 1449 Type 3.

EFI Electronics Corp. - Model 453 (15 A Overload Protection)
Wiremold Sentrex “High Performance” - Model M65 (10 A Overload Protection)
Joslyn Electronic Systems - Model 1203-03 (15 A Overload Protection)
Pass and Seymour - Model PS7 (15 A Overload Protection)
Hubbell Model HBL6PS350A (15A Overload Protection)
Leviton Model 5300-PS

2.7 Provide a device plate to suit each particular application. Cover all empty outlet boxes with a blank plate. Coverplates shall be manufactured by Pass and Seymour, Hubbell, Cooper, Bryant, Leviton or Mulberry; Taymac is an acceptable manufacturer for weatherproof non-metallic coverplates Multi-Mac Series, “While-In-Use” type, 3.5 inches depth, ‘Extra Duty’, opaque grey, locking tab. Provide jumbo size plates for outlets installed in masonry walls.

2.8 In finished spaces, wall plates shall be nominal .032 inch thick, made of 302 high nickel stainless steel with brushed satin finish and beveled edges. Screws shall be metal with countersunk heads and finished to match plates. Sectional plates will not be permitted.

2.9 Coverplates for telephone and other communication system outlets shall be a blank coverplate or shall have a 0.625 inch diameter grommeted opening unless indicated otherwise on the drawings or in the respective communication system specifications. Color and material of plates shall match plates provided for other wiring devices.

PART 3 - EXECUTION

3.1 Locate devices as shown on the drawings, coordinate exact location with other trades, to avoid interference. Check for potential interference from door swings, cabinets, heating equipment and other wall mounted devices.

3.2 Clean debris from outlet boxes.

3.3 Install receptacles with grounding pole on bottom.

3.4 Verify each receptacle device is energized and test each device for proper polarity.

3.5 Adjust devices and wall plates to be flush and level.

END OF SECTION
PART 1 - GENERAL

1.1 Safety switches and other fusible protective devices provided under this contract shall be complete with fuses properly sized to protect the feeders and equipment served.

1.2 Fuses shall not be shipped installed in switches in electrical equipment nor shall they be shipped to the job site until the equipment is ready to be energized. Fuses shall be of the same manufacturer to retain selectivity as designed.

PART 2 - PRODUCTS

2.1 Manufacturers shall be Bussmann, Mersen, Littelfuse or Edison.

2.2 Fuses shall be current limiting with 200,000 amperes interrupting capacity, all shall be UL labeled.

2.3 Fuses, 601 ampere to 6,000 ampere (bolt type dimensions) shall be UL Class "L" fuses. The size and type is indicated on drawings; Bussmann HI CAP time delay fuse KRP C shall be used.

2.4 Fuses with ampere ratings 1 ampere to 600 ampere (standard dimensions) shall be UL Class RK 1. The size and type is indicated on drawings. Bussmann LOW PEAK Time Delay fuse LPN RK (250 volts) or LPS RK (600 volts).

2.5 Where Bussmann specific fuse types are indicated above or on the drawings, acceptable fuses by cross reference of manufacturers are:

<table>
<thead>
<tr>
<th>Voltage UL Class</th>
<th>Ratings</th>
<th>Bussmann</th>
<th>Mersen</th>
<th>Littelfuse</th>
<th>Edison</th>
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<td>KRP C</td>
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<td>JTD( )</td>
<td>JDL( )</td>
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</tbody>
</table>

PART 3 - EXECUTION

3.1 Place a fuse identification label showing type and size inside door of each switch. Use fuse reducers where fuse gaps are larger than fuse dimension.

3.2 Verify fuse types before installation for proper application by voltage and ampere ratings; fuses protecting motors shall not exceed 150 percent of motor nameplate amps. (Applies to fuses in sizes 600 amps and below.)

3.3 Furnish the Owner with a minimum of 10 percent of quantity of each size installed, but not less than one complete set of three spare fuses for each size of fuse furnished. Provide cabinet with door and latch, install adjacent to main service entrance equipment or where there are only a small quantity of spare fuses, provide a spare fuse board adjacent to each applicable fused panel and mount fuses on backboard. Provide a typewritten bill of material and install in plastic cover to inside of cabinet door.

END OF SECTION
PART 1 - GENERAL

1.1 Provide disconnect switches, fused and non-fused, where indicated on the drawings and in the specifications, and where required by the N.E.C.

PART 2 - PRODUCTS

2.1 Disconnect switches shall be listed by Underwriter's Laboratories and shall be manufactured by Square D, Siemens, G.E. or Eaton. All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

2.2 Switches shall be Heavy-Duty Type, NEMA 1 enclosures, non-fused except where fuses are specified or required to protect wiring from overload; provide raintight NEMA 3R type enclosures for outdoor applications unless otherwise noted.

2.3 Disconnect switches shall be quick-make, quick-break, externally operated with door interlocked with operating handle. Provide solid neutral and ground bars where indicated or where required by the application.

2.4 Disconnect switches shall have multiple padlock provisions in the off position.

2.5 The fuse holders shall be designed for Class "R" rejection type fuses.

2.6 Refer to "Identification for Electrical Systems" Section for nameplate requirements.

PART 3 - EXECUTION

3.1 Mount top of wall mounted disconnect switch 6 ft.-0 inches above floor where space permits.

3.2 Coordinate location of disconnect switches to avoid interference with other equipment and trades.

END OF SECTION
PART 1 - GENERAL

1.1 Schedules on the drawings list motors, starter requirements and associated controls. Motor starters and disconnects shall be furnished under this Contract except where specifically shown or specified to be furnished by other trades. Motor starters and disconnects shall be manufactured and rated in accordance with NEMA, UL and IEEE standards. IEC RATED CONTACTORS AND OVERLOADS ARE NOT ACCEPTABLE.

1.2 Refer to "Disconnect Switches" Section for switch requirements.

1.3 All motor starters shall be rated for the available fault current at the point of application.

PART 2 - PRODUCTS

2.1 Manufacturer Allen Bradley, whose catalog numbers are used herein as a standard, or equivalent by Square D Type S (Class 8536), G.E. Series CR306, Eaton Class AN16 or Siemens “U.S. Series”. All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

2.2 Where new motor starters and disconnect switches are to be installed in existing motor control centers they shall match existing units.

2.3 Magnetic starters shall be line voltage suitable for the service listed on the drawings. Each starter shall have one extra auxiliary contact for future control purposes, a 3 leg melting alloy thermal overload relay on a single block, a manual reset mechanism, a 120 volt control coil, Bulletin 509. Contractor shall have the option of installing Bulletin 512 combination starters in place of separately mounted switches and starters. Disconnects shall be non-fused type unless otherwise specifically indicated or required by NEC.

2.4 A HAND-OFF-AUTO selector switch shall be mounted in the face of each starter enclosure. The selector switch shall be so wired that when it is in the HAND or AUTO position, all SAFETY controls are wired in series with the selector switch; all CONTROL DEVICES shall be wired in the AUTO position only.

2.5 Each starter enclosure shall have a suitable 120 volt secondary control transformer fused separately on each phase of the primary and secondary, and grounded on the secondary.

2.6 Each starter shall have a red LED pilot light mounted in the face of the starter enclosure. The LED shall be wired so it will be on when the motor is energized.

2.7 Magnetic starters shall be furnished for motors, one horsepower and greater or any 3 phase motor, unless indicated otherwise on plan.

2.8 Provide adjustable phase failure-reversal-undervoltage relay protection on all motor starters NEMA size 3 and larger; wire ahead of the H-O-A switch.

2.9 Manual starters with thermal overload protection shall be furnished for fractional horsepower, single phase motors unless otherwise noted and shall be Bulletin 600 with a pilot light, flush mounted in finished areas.

2.10 Unless otherwise noted or required by Code, safety switches shall be Heavy Duty Type, NEMA 1 enclosures, non-fused except where fuses are specified or required to protect wiring from overload. Switches shall be quick make, quick break, externally operated with door interlocked with operating handle and padlock provisions in OFF position. Provide solid neutral and ground bars where required. Switches located outside shall be raintight NEMA 3R, unless otherwise noted.
PART 3 - EXECUTION

3.1 Check full load ampere and service factor rating of each motor after installed and furnish the proper size overload heater elements to protect the motor.

3.2 Those portions of interlock and control wiring which are required but not prewired, shall be done in the field.

3.3 Motor starters and disconnect switches shall be conveniently accessible; all NEC minimum clearances from walls, pipes, ducts, equipment, etc., shall be maintained. Locate as inconspicuously as possible in finished spaces.

3.4 Refer to "Identification for Electrical Systems" section for nameplate requirements.

3.5 Place label in each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage / phase, OL type and OL size.

END OF SECTION
PART 1 - GENERAL

1.1 Refer to schedule on the drawings for information on luminaires, lamps and manufacturers. Luminaires of manufacturers other than those listed, if offered, shall be on a substitute basis and so listed as a substitute with the bid. (Refer to Section 26 05 01, para. 2.4 B.)

1.2 The catalog numbers listed on the schedule do not necessarily have complete prefix and suffix designations for placing the luminaire order. The Contractor shall verify these numbers and include in his bid the necessary plaster frames, accessories, trim, mounting hardware, etc. to achieve a coordinated installation with ceiling types indicated on the architectural drawings and in specifications. The Contractor shall provide any hardware indicated by notes on the fixture schedule.

1.3 Luminaires, ballasts and individual components shall bear UL label. All ballasts including compact fluorescents shall be high efficiency and high power factor (HPF).

1.4 Where luminaires are installed in fire rated ceilings the following methods shall be utilized:
   A. Fire rated light covers
   B. Fire rated boxes or custom-built fire rated boxes
   C. Detail of installation method shall be submitted.

1.5 Submittals
   A. Detailed cut sheets for LED luminaire complete assemblies (including drivers) shall be submitted for approval with shop drawings. Identifying pertinent information such as the manufacturer, frequency operation, THD, crest and ballast factor, reset thermal protection, etc. Also, submit emergency battery ballast cut sheets for review. Shop drawings will be rejected if required information is not submitted.
   B. Submittals shall include dimensions, ratings, performance data and components of each luminaire. Where indicated on schedule, submit two (2) color chips illustrating luminaire finish color.

PART 2 - PRODUCTS

2.1 LED Luminaire Components
   A. LED Luminaire
      1. LED luminaire shall be rated for an installation/ambient temperature from -40 degrees C to +40 degrees C.
      2. LED luminaire shall be modular in design (when applicable per the basis of design) with the ability to replace drivers, light engines, arrays, optics, reflectors, etc., without having to replace the entire luminaire.
      3. The heat sink shall be easily accessible for maintenance or cleaning to maintain the overall thermal performance of the luminaire within specifications. The light engine and driver shall be easily accessible for maintenance.
      4. LED luminaire (type V distribution) shall have an even distribution of luminous intensity within the 0 degree to 90 degree zone. Luminous intensity at any angle within this zone shall not differ from the mean luminous intensity for the entire 0 degree to 90 degree by more than 10 percent.
      5. Exterior LED luminaire shall be full cutoff or fully shielded as defined by IESNA-RP-8.
6. LED luminaire shall come standard with the ability for full dimming.
7. LED Luminaire shall have a minimum of 5 year warranty.

B. LED/LED Module

1. LED/LED Module(s) shall be manufactured by:
   a. Nichia
   b. Cree
   c. Achriche
   d. Phillips
   e. Osram/Sylvania
   f. Approved Equal (By Engineers approval)
2. LEDs shall be of the highest production quality.
3. LED/LED Module shall be rated for 50,000 hours of life at 70 percent output (L70) and shall have been tested in accordance with IESNA LM-79, LM-80, and TM-21.
4. LED/LED Module manufacturers shall adhere to LED package manufacturer guidelines, certification programs, and test procedures for thermal management.
5. LED/LED Module(s) shall be rated for a minimum luminous efficacy of 80 Lumens per Watt (lm/W).
7. LED/LED module shall have a minimum CRI of 70. High CRI where noted shall be minimum 85 (sample R1 – R8) with sample R9 minimum 80.
8. LED/LED Module(s) shall have one of the following designated CCTs (Correlated Color Temperature) per ANSI C78.377-2008 and all within the 7-step chromaticity quadrangles as defined below:
   a. 2700 K
   b. 3000 K
   c. 3500 K
   d. 4100 K
   e. 5000 K
9. LED/LED Modules shall originate from a common manufactured batch source.
10. Contractor shall provide 5 percent of each module specified as spare in original sealed packaging and transport to the Building (and put in storage) as directed by the Owner.

C. LED Driver

1. The driver shall have 50,000 hrs. of anticipated/rated life. Minimum efficiency of 85 percent at full load conditions.
2. UL 8750 approved.
3. Driver shall meet UL Class 2 for use in dry or damp location.
5. Driver shall have inherent short-circuit protection, self-limited, overload protected. (UL 1449)
6. Driver shall have a Class A sound rating.
7. Driver rated for 100 to 277 volt input. Power factor .90 or higher.
8. All drivers shall provide full LED dimming range. The drivers in every LED fixture shall have the capability to be dimmable, whether indicated to be dimmed or not on the drawings.
9. Driver shall have a minimum of 5 year warranty.
10. Contractor shall provide 5 percent of each driver specified as spare in original sealed packaging and transport to the building (and put in storage) as directed by the Owner.

D. The complete LED luminaire assembly shall be of the latest and highest efficacy design available.
E. Equal fixtures/luminaires provided other than the first name specified luminaire, shall at a minimum, provide the same if not more delivered lumens. Additionally the “equal” luminaire shall not exceed the first name specified luminaires total system input watts.

2.2 Battery Powered Exit and Emergency Lighting Luminaires

A. Each unit shall consist of a battery, lights, lamps, automatic controls and connection to the lighting circuit ahead of all switches. Operation shall be such that the battery is maintained constantly charged under normal conditions; upon a loss of normal power, the light shall be switched on and the operating current obtained from the battery.

B. Units shall be UL labeled. Refer to drawings for mounting, capacity and manufacturer.

C. Fasten battery operated exit and emergency lighting units to wall or ceiling using factory-furnished bracket and make rear concealed electrical connection.

D. Electric source shall be from unswitched active lighting circuits only, to ensure that battery will be charged from an active circuit.

2.3 LED AC/Emergency Driver Units – Battery Type

A. Emergency lighting shall be UL listed and labeled and shall be provided by using standard LED luminaires equipped with a self-contained mounted battery-inverter power pack. Furnish and install with each designated luminaire a power pack unit to operate one lamp assembly upon loss of normal power. Initial output rating shall be minimum 3.1 watt. Warranty shall be 5 years from date of acceptance.

B. Emergency operation shall be fully automatic with the power pack unit capable of driving the selected lamp at rated output for a minimum of 90 minutes with a lumen depreciation no greater than 35 percent.

C. Power pack units shall include a sealed maintenance-free nickel cadmium battery, a Solid-state charger, an automatic transfer circuit, a low voltage battery disconnected circuit and a high frequency inverter. An accessible test switch and AC “on” pilot light shall be installed in the fixture and require no field wiring.

D. The power pack’s inverter electronics and battery driver shall, without requiring modification, be compatible with standard driver and lamp assembly supplied and shall not affect normal luminaire operation and shall be used with either a switched or unswitched luminaire. Connect to an unswitched hot leg for either base for charging/loss of power.

E. Provide remote test switch for installation where indicated on plan or where routine testing would be difficult due to luminaire location or accessibility. This option shall consist of a pushbutton test switch and AC “on” pilot light mounted on a white nylon single gang switch plate.

F. LED type inverter units shall be Dual Lite or equal by Chloride, Siltron, Power Sentry, Bodine, Side Lite or IOTA Engineering Company.

PART 3 - EXECUTION

3.1 Luminaire Hanging and Supporting

A. Support each surface mounted or suspended luminaire in a minimum of two locations. In addition, where luminaires are in a continuous row, they shall be fastened together on each end in two places. For suspended luminaires provide pendant length required to suspend luminaire at indicated height.
B. Recessed luminaires shall be supported at all four corners. Additionally, securely fasten each luminaire to the ceiling framing member by mechanical means such as bolts, screws, rivets or approved clips; install a minimum of one on each of the four sides of luminaire. This Contractor shall coordinate luminaire locations and luminaire weight with the trade installing the ceiling system to ensure adequate hangers are installed to support the weight of the ceiling plus twice the weight of each luminaire.

C. Luminaires in ceilings of the suspended lay in type shall be installed so that the long dimension of the luminaire is supported on the main support members of the ceiling system.

D. In addition, all recessed LED luminaires for lay in ceilings shall be equipped with at least two galvanized steel safety support wires, or chains, attached from the luminaire housing to the structure independent of the ceiling system; hangers supporting ceiling system shall not be used.

E. Install safety cable / chain support for luminaires per manufacturer’s direction. Coordinate structural connection with Architect.

F. Do not support light fixtures directly from light weight roof decks. Provide supplemental angle iron support as required. Do not connect to bottom cord of roof joist without supplemental angle iron ties to the upper cord of joist.

G. Wire battery powered emergency fixtures to circuit constantly on. For lamps in fixtures which are switched the charging / sensing circuit shall be extended from ahead of room switch.

3.2 Alignment and Cleaning

A. Luminaires shall be mounted straight, level and true to the building lines. Warped or damaged luminaires shall be replaced or repaired to the satisfaction of the Architect and Owner.

B. Immediately preceding the final inspection, this Contractor shall thoroughly clean all luminaires of dust, dirt, grease, fingermarks, etc. All lamps shall be operating at the time of Owner’s acceptance.

C. Coordinate location of luminaires carefully with the Architectural reflected ceiling plan. Verify that no surface mounted luminaire interferes with door swings.

1. Coordinate locations of luminaires with mechanical ducts, sprinkler pipes/heads, smoke alarms and fire alarm devices prior to rough-in to prevent conflicts.
2. Where reflected ceiling plans indicate a larger quantity of luminaires than that shown on the electrical drawings for a particular space, the reflected ceiling plan shall be followed for that space.

D. Adjust all adjustable fixtures to the satisfaction of the Engineer and the Owner.

3.3 Turn over spare LED components to Owner.

END OF SECTION
PART 1 - GENERAL

1.1 Summary

A. The products specified in this section shall provide a lighting control panel system in one panel with 8 relays. Each relay shall be able to take input from low voltage input devices including occupancy/vacancy sensors, daylight sensors and switch stations for indoor and outdoor lighting applications.

B. The system shall be capable of turning lighting loads on/off or dimming using inputs, schedules, time clock and astronomical clock programming.

C. The intent of these specifications is to provide a complete, functional, lighting control system for the control of LED lighting as indicated on the plans.

D. Where shown on the drawings, the contractor shall furnish and install a low-voltage lighting control system consisting of, but not limited to, panels with relays, 0 - 10vdc dimmers, graphic user interfaces, controllers, enclosures, switch stations, photo sensors, occupancy sensors, low voltage Class 2 wiring for all input devices and light fixtures and data wiring between master and secondary panels as required for a complete, operable lighting control system.

E. Wiring shall be sized to accommodate no greater than 3 percent voltage drop.

F. The system shall be capable of loading and saving programming via SD Card at the user interface.

1.2 Submittals

A. Manufacturer shall provide submittal drawings and data for approval prior to beginning manufacture of equipment in printed and/or electronic formats.

B. Submittal package shall include, but not be limited to, the following: (Submittals that do not contain all the information listed below will not be considered for approval)

1. Bill of Materials: Provide as part of the submittal package a detailed itemized listing of all proposed equipment, including quantities and capacities for all major system components.

2. Product Data Sheets: Provide as part of the submittal package detailed product data sheets for all major system components.

3. Shop Drawings: Submittal shall include shop drawings that accurately represent the system or systems specified herein. Shop drawings shall include the name of the project, quantity and physical dimensions of all major system components, wire sizes and counts for all required connections between system components.

4. Contractor/Commissioning Worksheet – must be completed prior to factory start-up.

5. Specifications Compliance: Submit a line-by-line comparison that describes the differences between each specifications requirement and the equipment / systems being proposed. Comparison shall include a complete listing of how the proposed equipment / systems differ from that specified with regard to size, quantity, quality, method of control, features and functions, control software functions and installation requirements.

1.3 Quality Assurance

A. Factory Assembly: All devices shall be factory assembled and tested. All system components shall arrive at the job site completely pre-wired and ready for installation, requiring only the connection of lighting circuits and control terminations. All connections shall be made to clearly and permanently labeled termination points.
B. Component Testing: All system components and assemblies shall be individually tested prior to assembly. Once assembled, all finished products shall be tested for proper operation of all control functions per specifications prior to shipment.

C. NEC Compliance: All system components shall comply with all applicable sections of the National Electrical Code (NEC) as required.

D. NEMA Compliance: All system components shall comply with all applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

E. FCC Emissions: All applicable equipment shall comply with FCC emissions standards specified in Part 15, sub-part j for commercial and residential applications and shall bear labels indicating compliance testing. Equipment that does not meet these standards shall not be acceptable.

F. All applicable products must be ETL or UL Listed or other acceptable national testing organization.

G. Title 24: All applicable system components and the system as a whole shall be certified as complying with Title 24 requirements.

H. Manufacturer must have a minimum of 10 years of experience manufacturing lighting controls.

1.4 Project Conditions

A. Do not install equipment until the following conditions can be maintained in the spaces where equipment is to be placed:

1. Ambient temperature: 0° to 40° C (32° to 104° F).
2. Relative humidity: Maximum 95 percent, non-condensing.
3. Lighting control system must be protected from dust during installation.

1.5 Warranty

A. All devices in lighting control system (drivers, controllers, photo cells, etc……) shall have a 5 year manufacturer’s warranty.

B. Warranty period shall begin after the completion of the installation and the system’s start-up and training, the point at which the system owner receives beneficial use of the control system or 1 year after shipment from the manufacturer, whichever occurs first.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Base Bid Manufacturer:

1. Hubbell Building Automation, Inc.
   a. Panels: CX Lighting Control Panels
   b. Relays: CXR Relays
   c. Devices: OMNI™ and LightOWL™ Series sensors, LVS series low voltage switches and Luxstat photo sensors

2. Basis of design product: Hubbell Building Automation CX Panels or subject to compliance and prior approval with specified requirements of this section, one of the following:
   a. HBA CX Panels and low voltage input devices

B. Substitutions: Lutron, NLight, Encellium
1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices and wiring. The contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 System Requirements

A. System shall consist of up to one panel with a maximum of 16 relays.

B. Low voltage input devices including occupancy/vacancy sensors, daylight sensors and switch stations shall be connected to the panel and software assignable to any type. Power and control for LED indication at switch stations shall be provided.

C. Low Voltage cable shall be unshielded multi-conductor Class 2 #18 GA stranded or solid copper conductor. Number of wires per cable varies based on device to be connected.

D. Panel shall be capable of automatic recognition of relay types when relays are mixed or changed in the panel. Systems requiring programming of relay types shall not be acceptable.

E. User interface shall be Color LCD Display with a minimum of 8 lines x 24 characters. Home Screen display shall include real time clock display including Hours/Minutes/Seconds, Time Zone, Date with Day of the week and Panel Name. Full text HELP screens shall be available at all Main and sub-Main level screen options.

F. System shall have an intuitive and easy to use Graphical User Interface (GUI) to control, monitor and schedule individual devices or groups of devices.

G. System shall remain fully functional during the programming process. All programming changes shall take effect immediately as they are programmed.

H. Dimming interface shall provide eight 0 - 10vdc dimming channels per option card for a maximum of 24 dimming channels (three cards) per panel.

2.3 Panels

A. Panels shall be available in 8 or 16 relay capacities. Panels shall be factory assembled fully populated with no relays installed for field installation of relays in less than a full panel or combinations of relay types. Panels shall be capable of having mixed types of relays installed in any slot or combination without any programming to assign relay type. Programming shall be provided by the contractor once all the relays have been installed on site. Coordinate programming and time of day settings with owner prior to work and provide accordingly.

B. Panels shall provide input power leads to accommodate 120VAC, 208VAC, 220VAC and 277VAC OR 347VAC and 480VAC. Maximum power consumption for 4 and 8 relay shall not exceed 40VA and for 16 and 24 relay panels shall not exceed 100VA.

C. Panel housing shall be NEMA 1 surface mounting powder coated after fabrication. Knock outs shall be provided in the top and bottom of the housing. The cabinet shall have a hinged door and be provided with a locking mechanism. The user interface is integral with the door for access with the cabinet locked.

D. The panels shall be configured with control inputs and outputs depending on panel size. Each relay card has one input that can be configured to control any relay or group. All inputs are
programmable in any combination and to any relay. The input types are assigned through program selections. Each input terminal can be used for low voltage switches, photocells, or motion sensors.

E. Panel firmware and programming shall be stored in non-volatile memory and shall be unaffected by loss of power events. The system clock shall be provided with battery back-up that will remain accurate for a minimum of 7 years. Panel system diagnostics shall be provided to check battery performance.

1. Panels shall be available as a Master or Secondary Panel for 8, 16, or 24 relay sizes. 4 relay versions shall be available as Stand Alone type.

2. A System of two panels shall be possible using any combination of one Master panel (8, 16, or 24 relay) and one Secondary panel (8, 16, or 24 relay). Panels shall be connected using standard CAT 5 or CAT 5e 8 conductor cable up to 750 feet in overall length. Panels shall be able to receive RJ-45 jacks or have individual wired connected in pressure style terminal blocks.

3. Input voltage shall accommodate 120VAC, 208VAC, 220VAC, 277VAC, or optional 347VAC and 480VAC.

2.4 Relays

A. CX Panel is supplied with no relays installed and combinations of relay types and quantity are field installed by the electrical contractor.

B. Electrical contractor shall provide and install quantities of lighting control relays as indicated on the drawings and schedules as specified herein. Lighting control relays shall be individually UL and CUL listed and shall bear labels indicating compliance. Lighting control relays shall be tested to UL standard 916 and UL standard 924 for both safety and endurance and bare labels signifying compliance. Lighting control relays shall be cycle tested ON/OFF @ FULL LOAD switching for all loads that the relay is rated to control.

C. Relays shall bear individual label indicating all load ratings by type and Short Circuit Current Rating (SCCR). Relay SCCR is indicated below. Relays with SCCR lower than the values indicated below will not be accepted.

D. Lighting control relays shall be specifically designed for control of 120, 277 or 347 VAC loads for single pole relays and 208 VAC for two pole relays. Lighting loads including but not limited to incandescent, low-voltage, motor loads, neon, cold cathode, LEDs, fluorescent and HID lighting sources at the ratings listed below.

1. CXR2N - 20A/1P Normally Open (N/O) Relay – 20A @ 120VAC, Tungsten; 16A @ 120/277VAC Electronic Fluorescent Ballast; 20A @ 120/277VAC, Standard Fluorescent Ballast; 1H.P. @ 120VAC, Motor Load; ¾ H.P. @ 277VAC Motor Load. 14,000 Amps @ 277VAC SCCR (Short Circuit Current Rating)

2. CXR3L – 30A/1P Latching Relay - 20A @ 120VAC, Tungsten; 16A @ 120/277VAC Electronic Fluorescent Ballast; 30A @ 120/277VAC, Standard Fluorescent Ballast; 1H.P. @ 120VAC, Motor Load, 20A @ 347VAC, electronic Ballast, 20A @ 347VAC, standard ballast. 14,000 Amps @ 277VAC and 347VAC SCCR (Short Circuit Current Rating)

3. CXRTN - 20A/2P Normally Open (N/O) Relay - 20A @ 480VAC, Standard Fluorescent Ballast; 2H.P. @ 480VAC, Motor Load. 14,000 Amps @ 480VAC SCCR (Short Circuit Current Rating)

4. CXRTC - 20A/2P Normally Closed (N/C) Relay - 20A @ 480VAC, Standard Fluorescent Ballast; 2H.P. @ 480VAC, Motor Load. 14,000 Amps @ 480VAC SCCR (Short Circuit Current Rating)
E. Each lighting control relay shall include a manual override means of turning the relay ON or OFF without the panel controller connected or operational. Each lighting control relay shall include an LED visual indicator showing the current status of the relay itself.

2.5 Dimmers

A. Each dimming option card shall provide capability for eight industry standard 0 - 10vdc dimming channels each capable of sinking a maximum of 30mA of current supplied by dimming ballast(s) or LED drivers. The dimming option card shall be plug-in style for simple field installation where required.

B. Eight 0 - 10vdc dimming control connections shall be provided per card via removable plug-in terminal blocks. The dimming control lines shall automatically open upon loss of normal control power to the CX panel insuring that all connected dimmed loads will be at 100% brightness if connected to emergency power.

C. Each dimming option card shall provide four RJ45 jacks for connection of single gang decorator style dimming switches. Provide capability for manual raise/lower, on/off and preset type low voltage switches. Dimmers shall also be controllable via panel schedules, daylight harvesting via photocell, and integral demand response limiting feature.

2.6 Panel Programming Capabilities

A. The Panel shall have the following System Settings capabilities:

1. Date/Time Settings: System shall allow time setting of hours/minutes/seconds for 12 or 24 hour format. Display shall be configurable Month-Day-Year, Day-Month-Year or Year-Month-Day. Date and Time including time zone shall display continuously on the panel home screen.

2. Astronomical Clock: System shall use longitude and latitude input with sunset-sunrise offsets adjustable from 1-60 minutes before or after. System shall include major city look-up selection that auto-populates longitude and latitude values.

3. Daylight Savings Time: Automatically adjusts the clock at the appropriate calendar dates standard, with manual date adjustment.

4. System shall have 4 Open/Close time schedules. These allow for schedules and masking to be tied to one of four master Open/Close times.

5. System shall provide for naming of Panels, Relays, Dimmers, Groups, Schedules, Holidays, Inputs, Outputs and Users. Names shall be up to 19 characters long and include upper/lower case alpha/numeric characters.

6. Panel shall have after hours sweep function that allows for relays to be swept off based on a designated start time (Clock Time or Open/Close Time) with up to four sweeps with intervals of 1-120 minutes.

7. Panels shall provide blink/alert capabilities. When relays are selected as Blink type, then switches mapped to control relays or groups will provide override functionality at schedule OFF events. Blink/warn may be set at 1-15 minutes before the schedule OFF event. Override duration may be selected from 1-120 minutes. Blink/warn recur if lights are still on at the end of the override duration. Schedule ON events cancel and impending override OFF that would occur after the ON event.

8. Panels shall be capable of setting relays to be ON, OFF or return to the LAST state upon return of power after a loss of power event. The panel shall verify the proper state of the relays for schedules that include both ON and OFF times and execute the appropriate ON of OFF command to bring the relays to the planned state.

B. Groups: System shall provide a minimum of 32 groups that can include any or all relays and dimmers in Stand-Alone, Master or Secondary panels.

C. Schedules: Provide 64 Schedules for 365 day programming (Battery back-up Real Time Clock).
1. Schedules may be selected as M-F or M-F + Saturday with a single input of recurring ON/OFF times.
2. Schedules may be created in the “All Days” type for any or all days with differing ON/OFF times per day.
3. All schedules shall have date range option, copy/paste function, and allow naming using pre-populated terms selection and/or individual letter/number input from the alphanumeric keypad.
4. Schedules may be programmed as ON only, OFF only or ON/OFF in a single schedule. Systems require separate ON and OFF schedules only will not be accepted. Priorities and Masking apply to schedules that are ON/OFF type.

D. Holidays: System shall provide the following Holiday functions.

1. A list of Standard U.S. holidays may be selected in a single screen that are recurring year to year without entering actual calendar dates. These holidays do not count as a part of the date specific holidays.
2. 99 date specific holidays shall be available to be programmed as blocked dates in schedules or to have Holiday Schedules applied to them individually.
3. 4 Holiday Schedules shall be provided that can be applied to date specific holidays. All normal schedule programming selections apply in the creation of Holiday schedules.

E. Inputs: Inputs shall be software assigned to any device input including motion sensors, switches, and photocells. Inputs are designed for use with Hubbell Building Automation devices as specified herein. Dry Contact Inputs shall be capable of receiving normally open or normally closed maintained or momentary inputs from non-HBA devices.

F. Outputs: Dry contact low voltage outputs shall be provided on 8, 16, and 24 relay panels for use in initiating signals from the CX panels to outside building systems. Output contacts may be programmed to mimic inputs and schedules. Dry contacts are rated Normally Open/Normally Closed, 24V AC/DC 50 mA. Output contacts may be programmed as maintained or momentary. 8 relay panels shall have 2 output contacts, 16 relay panels shall have 3 output contacts and 24 relay panels shall have 4 output contacts.

G. Demand Response: When equipped with the dimming option, the CX panel can be programmed to automatically limit the output to all dimmed lighting loads to a prescribed maximum demand response level. When activated by a simple maintained contact closure, all dimmed loads will immediately dim down to the maximum set level. Loads currently below the maximum level will remain at their current level. During a demand response event, dimmed loads may be controlled below the maximum set level but not above. At the termination of the demand response event, normal control will be restored.

H. The Panel shall provide System Tools as follows:

1. Manual Control: Control relays, groups, and schedules ON/OFF and control All relays ON/OFF. Dimmers may be set to dimmed levels between 0% and 100%.
2. System Status: View ON/OFF states of all relays, dimmers, groups, inputs and outputs. View actual sunrise/sunset time for the current date.
3. Save/Restore Programming: The system shall allow for programming to be saved to SD card via slot in user interface. The program can be restored using the upload function from the SD card. The system shall also allow for saving 3 back-up programs to non-volatile memory without the use of removable memory.
4. Access Control: The system shall be capable of creating up to 10 user profiles with 3 levels of access as follows:
   a. Master: Access to all program functionality.
   b. Limited: Access to limited changes to existing programming.
   c. View-Only: Allows for user to view all programming, but does not allow any changes or deletions.
5. Diagnostics: On-board diagnostics for battery, panel and relay communications.
6. Firmware update, controller version information, and system reboot functions.
7. System event logging to SD Card.

2.7 Occupancy/Vacancy Sensors

A. Sensor shall provide automatic switching of lighting load(s) within an area/zone based on the presence of human activity.

B. Sensor shall have a microprocessor and utilize IntelliDAPT™ technology to optimize the sensor behavior to fit occupant usage patterns and adjust sensitivity and time delay to changing conditions.

C. Sensor shall not require any manual adjustment at the time of installation or during operation.

D. Sensor shall adapt automatically to changing room conditions.

E. Sensor shall utilize either passive infrared, ultrasonic, or both passive infrared and ultrasonic technology to detect motion. Sensor shall not react to noise or ambient sound.

F. Sensor's microprocessor shall monitor PIR background levels and automatically make corresponding adjustments.

G. Sensor shall incorporate a dual element pyrometer and 12-element cylindrical Fresnel lens.

H. Sensor shall be provided with a variety of mask inserts for PIR rejection to prevent false tripping.

I. Sensor's microprocessor shall monitor ultrasonic frequency changes and automatically make corresponding adjustments.

J. Sensor's microprocessor shall automatically adapt to a continuous airflow situation.

K. Sensor shall be powered by the CX Panel directly for a maximum of 8 sensors for 4 and 8 Relay panels and 24 sensors for 16 and 24 relay panels. Projects requiring sensor quantities greater than listed above require the addition of HBA power packs and sensors utilizing RP optional remote contacts.

L. Sensor shall have an ultrasonic frequency of 32kHz or 40kHz depending on model.

M. Sensor coverage shall range from 0 to 2000 sq. ft. depending on model.

N. Sensor shall be available with a 110 degree, 180 degree, or 360 degree field of view.

O. Sensor shall recognize, as a false on, the failure to detect motion 6 seconds after motion is detected initially (turning on the lighting). The sensor shall decrease the sensitivity in response to the false on.

P. Sensor shall feature an 8-second time out install test mode, which will automatically revert to standard time out one hour after being put into test mode.

Q. Sensor shall have manual controls and override switches to force manual adjustments.

R. Sensor shall have controls behind a cover to resist tampering. All controls shall be accessible from the front of the sensor.

S. Sensor shall have timer that can be adjusted manually from 8 to 30 minutes.
T. Sensor sensitivity shall be adjustable from 0% to 100%.

U. Sensor shall have a control knob that sets the minimum setting for the timer in automatic mode.

V. Sensor shall have control knobs for setting the initial automatic sensitivity adjustments.

W. Sensor shall include non-volatile memory for retaining device settings during power outages.

X. Sensor shall have a switch to restore IntelliDAPT settings.

Y. Sensor shall have real time motion indicator LED's visible from the front of the unit. Red = Infrared, Green = Ultrasonic.

Z. Sensor shall be available with a Form C isolated dry relay contact for interfacing the sensor to auxiliary systems.

AA. Sensor input may be programmed for active and inactive times using the masking function in the CX Panel program.

BB. Sensor shall be ceiling or wall mounted (depending on model).

CC. Hubbell Building Automation Motion Sensors:

1. OMNI series ceiling mounting motion sensors shall be available as passive infrared, ultrasonic, both passive infrared and ultrasonic technology. Sensors shall be available in varying coverages including 500, 1000, and 2000 square feet and specifically designed for corridors.

2. LightOwl wall mount motion sensors shall be available as passive infrared, ultrasonic, both passive infrared and ultrasonic technology. Sensors shall be available in varying coverages including 1600 square feet and specifically designed high ceilings of up to 30 feet.

3. All sensors shall be available with optional Form C Relay.

2.8 Photocell (Daylight Sensor)

A. Sensor shall provide automatic daylight harvesting switching of lighting load(s) controlled by a relay or group of relays. When used with the dimming option, the sensor shall provide daylight harvesting capability via full range dimming.

B. Sensor shall be a closed loop daylight sensor with an internal photodiode that measure the ambient light in the space.

C. Sensor shall provide programmable ON & OFF set points.

D. Sensor shall support 4 light level ranges: 0.3-30fc, 3-300fc, 30-3,000fc and 60-6,000fc. Light level ranges shall be selectable via jumper switch.

E. Sensor shall display real time foot candle levels at the CX Panel user interface.

F. For daylight harvesting switching, to prevent cycling, sensor shall have programmable ON delay and OFF delay settings.

G. Sensor may be programmed for active and inactive times using the CX Panel masking program function.
H. Sensor shall be ceiling or wall mounted in the appropriate location for measuring the available daylight.

I. Hubbell Building Automation product number(s):
   1. Interior Daylight Sensor – Model #LUXSTATLS
   2. Outdoor (Exterior) Daylight Sensor – Model #LUXSTATLSO

2.9 Switch Stations

A. Switch Stations shall provide manual switching of lighting load(s) controlled by a relay or group of relays.

B. Switches shall be low voltage, momentary switches and shall be available in the following configurations:
   1. 1, 2, 3, or 4 Buttons without LED Indication
   2. 1, 2, 3, or 4 Buttons with LED Indication
   3. 2 Button raise/lower dimming
   4. Available in White (WH) or Ivory (IV) color

C. Switches shall be injection molded and designed to mount in a standard single gang junction box with standard decorator-style plate opening.

D. Switches shall have removable buttons for field replacement. Button replacement may be completed without removing the switch from the wall.

E. Switches with LED indication shall have a green LED that is illuminated when the switch is in the ON state.

F. Switches shall be programmable from the CX Panel user interface.

G. Switches may be programmed for active and inactive times using the CX Panel masking program function.

H. Switches shall have 4" low voltage CLASS 2 leads for connection CX Panel inputs. The switch shall have wiring diagram indicated by a label affixed to the switch housing. Dimming switches shall connect to the panel via standard CAT5 cable and connectors.

I. Hubbell Building Automation product number(s):
   1. Low Voltage Momentary Switch LVSM Series
   2. Low Voltage CX Dimming Switch LVCX Series

2.10 Power Packs

A. Power pack shall be a self-contained transformer and relay module measuring 3.69" x 2.33" x 1.36". Power packs are used as an auxiliary power supply for motion sensors when the total sensor count exceeds the maximum allowed count for a specific CX Panel.

B. Power packs shall have primary universal voltage inputs of 100-277VAC, 50/60Hz.

C. Power pack shall provide a 24 VDC, 150mA output.

D. Power pack shall provide low voltage inputs: Control On +12-24 VDC; Manual ON +12-24 VDC.
E. Power pack shall provide selectable manual control for: ON- to allow switches to turn lighting ON and maintain ON state with occupancy, and OFF- to allow switches to turn lighting OFF with or without occupancy.

F. Power pack shall provide overload protection. A momentary or continuous short of any of the control wires will not damage the device.

G. Power pack shall provide Zero Arc Point Switching to protect from the effects of inrush current and increase product life.

H. Power pack shall be capable of parallel wiring without regard to AC phases on primary.

I. Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.

J. Power and auxiliary relay packs shall be suitable for use in plenum applications.

K. For ease and speed of installation, power and auxiliary relay pack shall have 1/2" snap-in nipple for 1/2" knockouts and shall mount on the outside or inside of enclosure.

L. Hubbell Building Automation product number(s):
   1. Universal Power Pack, 1 SPST Output, 120-277VAC – Model #UVPP

2.11 Raceways
   A. Contractor shall provide separate conduits for all control wiring to fixtures, refer to plans for conduit size and routing.

PART 3 - EXECUTION

3.1 Installation
   A. All equipment shall be installed in accordance with manufacturer requirements and in compliance with all applicable local and national codes and requirements.

   B. All programming for this system is the responsibility of the contactor. The contractor is responsible to provide and pay for all technicians time, labor and programming required by the factory upon initial setup.

3.2 Site Verification
   A. Verify all wiring conditions installed under separate sections at the time of Panel installation as acceptable to and in accordance to the manufacturer's installation instructions supplied with the products.

3.3 Field Measurements
   A. The electrical contractor shall be responsible for field measurements and coordination of physical size as appropriate for the product location. The electrical contractor shall coordinate with all architectural requirements for the space that the panel is located.

3.4 Inspection
   A. The electrical contractor shall inspect all materials prior to installation and notify the manufacturer of any unacceptable materials prior to installation.
3.5 Site Protection

A. Contractor shall protect installed product and finished surfaces from damage during all phases of construction including storage, preparation, testing, and cleanup.

3.6 Factory Commissioning (Optional)

A. Upon completion of the installation, the system shall be commissioned by the manufacturer’s factory authorized representative who will verify a complete fully functional system.

B. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.

C. Upon completion of the system commissioning, the factory-authorized technician shall provide the proper training to the owner’s personnel on the adjustment and maintenance of the system.

END OF SECTION
PART 1 - GENERAL

1.1 Exit lighting and emergency lighting system wiring shall be run in conduit system which is completely independent of normal wiring systems.

1.2 Equipment to transfer power from a normal source to an emergency source are to be listed and labeled for load transfer.

1.3 Base bid includes four (4) additional exit lights of type “X1” and (2) type X2, complete with installation, mounting and 50 feet of conduit with circuitry per device. The exit sign shall be where designated by the Engineer. All unused exit signs shall be transported to the building area as directed by the Owner.

PART 2 - PRODUCTS

2.1 Exit lights with battery to have sealed, maintenance free nickel-cadmium battery which delivers 90 minutes capacity to emergency lamps. Test switch provides manual activation of 30-second diagnostic testing for visual inspection. Where noted for self-diagnostic testing fixture to operate 30 seconds every 30 days and 90 minutes annually. Performing diagnostic of LED light source, AC to DC transfer, charging and battery condition.

2.2 Battery powered emergency light. Unit to include test switch, status indicator, and rechargeable battery. Maintenance-free nickel cadmium to provide 90 minutes of emergency power. Charger to have two charge rates and automatically recharges after battery discharge. A low voltage disconnect to prevent battery damage from deep discharge. (Self-diagnostics testing, where noted, operates 30 seconds every 30 days and 90 minutes once annually. Lights to indicate diagnostic evaluation of LED light source, AC to DC transfers, charging and battery condition.)

PART 3 - EXECUTION

3.1 All circuits shall have dedicated neutral conductor.

3.2 Adjust coverage of occupancy sensors and dimming control.

3.3 Test system operation for full 90 minutes witnessed by the AHJ. Provide report of required corrections, of any.

3.4 Batteries shall carry a five year warranty.

END OF SECTION
**COMMON WORK FOR COMMUNICATIONS**

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APRIL, 2019
1.1 Refer to Section 26 05 01 Basic Electrical Requirements which are hereby made part of Division 27 - Communications.

1.2 Special Note

A. All provisions of the Bidding Requirements, General Conditions and Supplementary Conditions, including Division 00 and Division 01, apply to work specified in this Division.

B. The scope of the Division 27 work includes furnishing, installing, testing and warranty of all work and complete Communication systems as shown on the T Series drawings, and as specified in Division 27 and elsewhere in the project documents.

C. The project drawings and specifications define scope of work for the various divisions. Such assignments of work are not intended to restrict the Construction Manager in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.3 Unit Prices

A. Unit Price UP-1

1. Provide unit prices to furnish and install all items identified in Specifications Section 27 XX XX work.

1.4 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the Division 27 work. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the local jurisdictional authority.

D. All electrical work shall be inspected and approved by the Ohio Division of Industrial Compliance who will issue the inspection certificate.

E. Upon completion of work, the Contractor shall furnish to the consulting State Architect the certificate of inspection and approval before final payment on contract will be allowed.

F. Final acceptance of all work will also be subject to the approval of the University Physical Plant Department.

1.5 Inspection of Site

A. Inspect the project site and the premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.
1.6 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible.
   1. The word “provide”, as used, shall mean “furnish and install”.
   2. The phrase “shall support” shall mean that no additional time, material or labor is required to have the specified referenced feature/function/capability fully operational.
   3. If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.
   1. Where there are quantity discrepancies of equipment shown on drawings and/or specifications, the Contractor shall provide the greater quantity.

D. The Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork, piping and communications wiring shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces About Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance and Access to Work Space – 110.34 Work Space and Guarding. Caution other trades to comply with this stipulation.

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Construction Manager’s decision shall be final in regard to the arrangement of conduit, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Construction Manager. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Construction Manager.

1.7 Asbestos Materials
A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 27 Contract. Necessary work of this nature will be arranged by the Construction Manager to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.8 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.9 Record Drawings

A. Maintain a separate set of field prints of the contract documents and show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work and within 90 days of system acceptance, these drawings shall be turned over to the Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.10 Operating and Maintenance Manuals

A. Assemble electronic copies each of operating and maintenance manuals for the Communications work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of replacement material required. Name and address of a qualified service agency.

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. Original purchase order number, date of purchase, name, address, and phone number of the vendor warranty information.

E. Copy of required test reports.

F. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

G. O&M Manuals shall contain the following information at a minimum:

1. Copies of all approved shop drawings with the Engineer's stamp.
2. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

3. Communications drawings updated with final as-built information. This shall be in the form of a complete set of Communications drawings with as-built information indicated in colored pen based upon actual field conditions.

4. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

1.11 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 27 work and develop a punch list to confirm that it is complete and finished. Then notify the Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.12 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year or the period of time as per specific specification section, from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. The use of equipment for temporary communication systems is not the start of the warranty period.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner’s personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

1.13 Software Support Agreement

A. Provide a software support agreement (SSA) with the project for each system with user software, that covers the entirety of the systems including all end devices, servers, etc. as part of the completed system for a period of not less than 1 year. Agreement shall cover software
upgrades, system patches and firmware releases and all labor/material to implement at no additional cost to the owner.

B. The SSA shall commence at the completion of the project after final inspection, system demonstration and system training.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electronic equipment provided under this scope of work shall be of a make/model that is currently in production at the time of installation.

C. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 Reference Standards

A. Where standards (NFPA, NEC, EIA/TIA, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

B. Cyber Security – NIST, UL 2900-1, ISO/IEC 27001

2.3 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.
D. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.4 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, pump curves, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Electronic format – Shop drawings may be submitted in electronic format utilizing PDF files. The submittal shall be organized by specification section and contain all required information within a PDF document for each specification section. The submittal shall be organized as follows:

1. Primary zip file contains a PDF of master transmittal cover page indicating the project name, submitting contractor, contact information and a list of all the sections with titles being submitted. This primary file shall also contain each of the individual PDF files for the individual sections being submitted.

2. Sub PDF file for each specification section organized as follows:
   a. First page - Cover page indicating the project name, submitting contractor, contact information, space for Engineer's stamp.
   b. Page(s) for contractor qualifications and project certifications.
   c. Page(s) for Bill of Materials (BOM) list including part numbers, quantities and references to specification section paragraphs for each part.
   d. Page(s) for manufacturer's data sheets.
   e. Page(s)/Drawing(s) for system diagrams, riser diagrams, block diagrams, etc.
   f. Drawing(s) for floor plans showing equipment locations.

D. Refer to individual system specifications for submittal requirements. At a minimum, shop drawings shall contain the following information:

1. A complete list of materials with model and part numbers and reference to the Part 2 specification paragraph number.
2. Shop drawings including manufacturer's product and cable data sheets specific to the project. Data sheets shall indicate exact model numbers and options specific to the project.
3. Floor plans showing location of all items of equipment. Drawings shall also indicate each location where 120 power is required.
4. Job specific schematic and point to point wiring diagrams showing all devices, number and size of wires, etc.
5. Contractor qualifications and/or Manufacturer's Certifications where specifically specified.
6. System software information, where applicable showing features, version, hardware requirements, and any other information required to ascertain conformance with specifications.

E. Equipment that does not fully comply with the specifications and which has not had this information presented in the shop drawing phase and approved, will be removed and replaced with specification compliant equipment at the contractor’s expense.

F. Cyber Security

1. Submit for approval the Cyber Security Hardening checklist that will be used for each system with associated network connected devices and software.

G. Any shop drawings that do not contain the minimum required information outlined herein and as specified elsewhere shall be considered incomplete and will not be reviewed. It is the contractor’s responsibility to fully read and understand all requirements for submittals for each section and to carefully and completely adhere to all requirements.

2.5 Network Enabled Devices with username/password

A. All devices which include a username/password shall be set by the contractor during construction as directed by the owner.

B. Devices shall not be left at default unless specifically directed by the owner.

C. Turn over a spreadsheet with all devices including device description, MAC address, IP address (if static) username and password.

PART 3 - EXECUTION

3.1 Testing

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

D. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Refer to specific sections for required testing of the various systems. Submit four (4) copies of reports indicating results.

E. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.

F. Instruments required for tests shall be furnished by the Contractor.

3.2 Equipment Cleaning

A. No fixed item of active AV/Network/Security electronic equipment shall be installed in any areas where active construction is generating significant amounts of dust/debris (drywall finishing, concrete sanding, wall painting, etc.). It shall be the responsibility of this contractor to
fully coordinate the activity of the general trades contractors with regards to floor/wall/ceiling finishing work to assure that active AV/Network/Security equipment is not exposed to or damaged by the materials and debris generated by these and similar activities.

B. No fixed item of passive AV/Network/Security equipment (such as cabling, faceplates, jacks, etc.) shall be installed in any areas prior to substantial completion of floor/wall/ceiling installation and finishing where the installation of such equipment will expose it to damage or defacement from those general trades activities. This contractor shall be fully responsible to fully protect/isolate any installed equipment from damage/defacements from the installation of or application of materials and finishes associated with the General Trades Work.

C. This contractor shall be responsible for fully protecting all equipment and providing final cleaning to restore equipment to its original pre-installation condition prior to project completion and turn-over to owner.

D. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents; verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O & M Manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

D. A minimum of 8 hours shall be allowed for instruction to personnel selected by the Owner. Instructions shall include not less than the following:

1. Show location of items of equipment and their purpose.
2. Review binder containing instructions and equipment and systems data.
3. Coordinate written and verbal instructions so that each is understood by personnel.
4. Manufacturer's representatives for the various special and communication systems shall give separate instructions.

E. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

F. Note that additional time for training, operating time, etc. may be required per other specification sections and shall be included. This section only establishes minimum requirements.

END OF SECTION
PART 1 - GENERAL

1.1 Scope of Work

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of:

1. Work area outlets including faceplates, jacks (voice, data, A/V), and labels. Boxes and conduit are being provided by Division 26 contractor.
2. Voice and data copper station cabling from work area outlets to telecommunications rooms including termination testing and labeling.
3. Voice and data work area equipment cords.
4. Voice and data horizontal cross-connect jumpers and patch cables including labeling.

1.2 System Description

A. Voice and Data station cabling (copper) system shall consist of:

1. Workstation outlet jacks.
2. Voice and data station cabling as specified herein from each workstation outlet to the termination equipment located in the Local Telecom Closet (TR-0X) or the Main Telecom Room (ER).
3. Station Cable Termination Equipment in each TR.
4. Final connections of the station cabling at the workstation outlet jack and the termination equipment in each TR.
5. Cross connects / patch cable to connect work area outlets to backbone / network electronics.

1.3 Quality Assurance

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, ANSI, ICEA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.4 Contractor Qualifications

A. Work shall be performed by a BICSI certified Telecommunications Contractor that is properly certified in the cabling system being installed. Contractor’s requesting pre-approval from the Engineer to perform the work as specified in this section shall meet the following requirements:

B. The Contractor must have an on-staff, full time RCDD. The personnel assigned to project manager for this project must be a current RCDD in good standing.

C. The personnel assigned to project foreman at the project site must be a minimum BICSI Level II certified installer.

D. The Contractor must have at least one BICSI Level I certified installer in the daily work crew.

E. The Contractor must hold a current certification from the manufacturer of the proposed cabling system solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer’s product and applications warranties as specified herein.
F. Requests for consideration shall be sent to the Construction Manager/Architect/Engineer (by mail or fax) and shall include the following:

1. Copy of the BICSI RCDD certificate for the Contractor’s on-staff, full time project manager.
2. Copy of the BICSI Level I, II and III certificate(s) for the Contractor’s on-staff, full time installation personnel. Prior to commencement of work, the Contractor shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be based upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.
3. Copy of the Voice/Data System Manufacturers Approval Certificate indicating that the Contractor is a certified installer of the proposed voice and data Cabling System Solution.
4. It will not be the responsibility of the Engineer to recognize or respond to incomplete or incorrect requests.

G. It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Engineer in writing. Refer to following requirements:

1. The Engineer will respond in writing to applicants who meet the requirements of this specification or to the project’s construction manager. This response will serve as formal notice that the Contractor is approved for the listed project.
2. Contractors who have not received approval from the Engineer prior to issue of formal contracts will not be approved to perform the work outlined in this specification section regardless of their qualifications.

1.5 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Qualifications

1. Copy of current BICSI and manufacturers certifications. Certifications that are past the expire date will not be accepted.
2. A statement of contractor’s qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

1.6 Relevant Standards

A. The Structured Cabling Installation shall comply with the following at a minimum:

1. All local, state and national codes
2. The National Electric Code (NEC)
3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA)/ Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

1.7 Related Sections

A. The following specification sections shall be deemed to be included in part or in whole and require close coordination to ensure total system interoperability and compatibility:

B. 27 15 43 – Communication Audio-Visual Horizontal Cabling
PART 2 - PRODUCTS

2.1 Structured Cabling System

A. The entire voice/data horizontal station cabling solution shall be a listed EIA/TIA cabling system solution from a single Manufacturer/Source as required by the Manufacturer/Source. Provide a listed Cabling System Solution utilizing cable/components from the following list of acceptable manufacturers:

1. Cable – Systimax, Belden (CDT), Berk-Tek, Commscope, General BICC, Mohawk,.
2. Components – Systimax, Belden (CDT), Hubbell, Leviton, Ortronics, Panduit, Siemon, Wiremold.

B. Horizontal cabling systems shall be permanent link configuration for voice and permanent link configuration for data.

C. Horizontal (station) cable shall be plenum rated.

D. Voice/Data station cabling shall be terminated utilizing EIA/TIA 568B standards.

2.2 Data Station Cable

E. Category 6, 4 twisted pair, non-shielded (UTP) station cable (capable of transmissions speeds in excess of 1.2 Gb/s and supporting IEEE 802.3ab Gigabit Ethernet) shall be used for serving data outlets. Cable shall be sequentially marked at 2 foot intervals. Color as selected by Owner.

F. Each cable shall be a dedicated home run from the workstation outlet jack to the data termination equipment in the local TR. Terminate cable at the workstation and at the TR termination equipment as specified herein and as indicated on the drawings.

G. Cable shall be labeled at both ends to indicate patch panel and port served. Coordinate labeling scheme with Owner and submit to Engineer for review.

2.3 Voice Station Cable

A. Category 3, 3 pair non-shielded (UTP) cable (capable of transmission speeds up to 10 Mb/s) shall be used for serving voice outlets. Cable shall be sequentially marked at 2 foot intervals.

B. Each cable shall be a dedicated home run from the workstation outlet to the voice termination equipment in the local TR. Terminate each cable at the workstation outlet and in the TR as specified herein and as indicated on the drawings.

C. Cable shall be labeled at both ends to indicate patch panel / punch block and port served. Coordinate labeling scheme with Owner and submit to Engineer for review.

2.4 Workstation Outlets

A. Data Jacks

1. Served from Category 6 cable shall be Cat. 6 rated, 8 position, 8 wire flush mounted modular jack (RJ-45). Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner. Modular mounting straps under duplex outlet faceplates shall not be acceptable.

2. Modular Plug Terminated Link (MPTL) – TIA 568.D-2 may be utilized to serve the following PoE powered end devices in lieu of surface outlets at the device location:
a. IP Cameras
b. Wireless Access Points (WAPs)

B. Voice Jacks

1. Served from Category 3 cable shall be 6 position, 6 wire flush mounted modular jack (RJ-11 / RJ-45). Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner.

C. Outlet Components

1. Faceplates shall be modular 6 port and shall accept the approved voice/data and video jacks including voice/data (RJ-11, RJ-45), Video (type F, type RCA, type BNC and S-Video), Audio (type RCA) and fiber (type ST, SC, LC and MT-RJ). Faceplates and jacks shall be by a single manufacturer. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner. Modular mounting straps under standard outlet faceplates shall not be acceptable.
   a. It shall not be acceptable to utilize standard outlet style-line faceplates with modular mounting straps for the jacks. All jacks must mount directly to modular ports within the faceplate.
   b. Where standard faceplates are not available from the manufacturer for the full line of jacks designed at a particular location, the contractor shall be responsible for providing a custom punched and engraved faceplate to meet the application.
2. Outlets designated to serve wall phones shall be of a type that is designed to support a wall mounted telephone. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner.
3. Outlets to be installed in floor boxes/pole-thru to be installed in faceplates, compatible with floor box/poke-thru make/model and secured within floor box/poke-thru. The use of loose or un-mounted jacks shall not be acceptable. Where floor box/poke-thru is provided by others, coordinate during construction with floor box/poke-thru to determine specific requirements for jacks and coverplate.
4. Each and every voice/data jack shall be labeled to corresponding patch panel and port. Each and every audio/video jack shall be labeled to indicate function (audio “L” and “R”, video, etc.). Coordinate labeling scheme with Owner. Labels shall be computer generated on an adhesive media and attached to the workstation outlet. Labels applied with pens or markers will not be acceptable.
5. Provide blank inserts for all unused ports.
6. Refer to drawings for arrangement of various workstation outlets including jack types and quantities within each outlet type. All voice/data/video/audio and fiber jacks indicated in the faceplate shall be deemed included in this specification unless specifically noted otherwise.
7. Outlet faceplates shall be same material/finish as faceplates of adjacent electrical outlets unless specifically indicated or otherwise required for custom applications.

2.5 TR/MER/Zone Enclosure Data Termination Equipment

A. Twisted pair angled modular patch panels, rack rail mounted, Cat. 6 rated, 110 termination, RJ-45, multi-port (24 or 48). Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in data racks in each TR. Each panel shall be fully loaded. Provide labeling for each connected port as coordinated with Owner.

B. Provide quantity of copper patch panels to accommodate complete termination of all installed copper station cables plus an additional 20 percent spare capacity.

2.6 TR/MER Voice Termination Equipment
A. 110 Style, Cat. 3 rated - Provide multi-pair, backboard mounted 110 Cross-Connect field with mounting legs. Provide arrangement of 50, 100 and 300 pair blocks as required by backbone cable termination in each TR. Refer to drawings for locations. Provide 3/4/5 pair terminal blocks, label holders and labels. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty.

B. Provide quantity of copper patch panels to accommodate complete termination of all installed copper station cables plus an additional 20 percent spare capacity.

C. Voice termination field – Blocks shall be used for both voice riser and station cabling. Separate blocks or rows of blocks will be used for riser cables and for station cables. Riser cable blocks shall be mounted on the left, station wire blocks will be mounted on the right in the TR. Terminate the riser cable following the standard telephone color code using the first row of pins on the left and the last row of pins on the right of the block. The riser and station cable will be fed up from the bottom of the 66 blocks standoff brackets. The 66 blocks are to be stacked no more than 4 blocks high with a 2-inch space between rows of blocks.

2.7 Station Cable Termination Assignments

A. Refer to the drawings for assignment of room station cabling to the respective TR termination equipment.

2.8 Patch Cables

A. This contract shall be responsible for providing all required patch cables to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications:

1. Data Station (copper) at Workstation – Provide a nominal 12 feet patch cable with every workstation jack to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths at various outlets depending upon the field conditions and the locations of the equipment which utilizes any given jack.

2. Data Station (copper) at TR – Provide a nominal 7 foot patch cable with every patch panel port to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths at various patch panel ports depending upon the field conditions and the locations of the equipment which utilizes any given port.

3. Voice Station at Workstation – None required. Telephone handsets cables are specified under section 27 31 13.

4. Voice Station at TR – Provide a nominal 7 foot patch cable with every patch panel port to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths at various patch panel ports depending upon the field conditions and the locations of the equipment which utilizes any given port.

PART 3 - EXECUTION

3.1 General Installation

A. Backboard mounted wiring connecting blocks shall be mounted such that the top of block is no more than 72 inches from the floor and the bottom of lowest block is no lower than 30 inches from the floor.
B. Cross connects / patch cables from voice backbone cable to voice station cables shall be furnished / provided by this Contractor, installed by 27 21 00 Contractor. Patch cables from data backbone and data station cable patch panels to network electronic equipment shall be furnished / provided by this Contractor, installed by Division 27 21 00 Contractor.

C. Refer to drawings for quantity and arrangement of voice/data/technology outlets including jacks and cabling.

D. Make all telephone and data terminations at TR termination equipment and at each workstation outlet jack utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

E. Coordinate color requirements for all jacks, station cables, patch panels, patch cables, etc. with Owner / Engineer. Color coding shall be consistent for all like equipment.

F. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.2 Wiring Installation

A. Voice and data station cable shall not exceed the EIA/TIA maximum lengths for the specified Category rating. The contractor shall be responsible for verifying adequate cable pathways to limit cable lengths prior to installation. Where existing or designed pathways do not allow for compliance to distance limitations for voice and data cabling, the contractor shall provide alternate pathway routes to the Engineer for review.

B. Interior - All voice/data/CATV station cables shall be run in conduit surface raceway from outlet to above accessible ceiling/ in conduit from outlet to nearest section of corridor cable tray/ extended from suspended cable management system out to nearest section of corridor cable tray/in conduit from outlet to local TR or ER extended via corridor cable tray and/or cable management system to local TR or ER as indicated on drawings and specifications. All cabling shall be run parallel or perpendicular to building lines. The contractor will be responsible for all cable management required to support cables per standards between installed fixed raceways (conduit, cable tray, wireways, etc.).

C. The drawings do not indicate specific routes for telecommunications cables. The Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

D. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a Cable Management System. Cable management system shall provide support no more than 5 feet on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1. Motors and transformers – 48 inches
2. Conduit and cable used for electrical power distribution – 12 inches
3. Fluorescent lighting – 5 inches
4. Power lines up to 2kVA – 5 inches
5. Power lines over 5kVA – 24 inches
6. Hot water/steam lines - Bare – 18 inches, Insulated – 6 inches

E. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

F. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

G. Each voice and data jack shall be wired with a dedicated home run. Each voice and data jack shall be identified. The jacks shall be labeled on the faceplate. Station cables shall be labeled at TR termination point with corresponding workstation outlet jack number.

H. Voice and data cables shall be handled and installed with extreme care. Twisted pairs shall be untwisted less than .5 inch at terminations for Cat. 5e, Cat. 6. Tie wraps shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 4 times the outer diameter of the cable. The cable manufacturer’s recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

I. Voice and data horizontal station cable shall not exceed the EIA/TIA guidelines for LINK distances. The permanent LINK shall be as defined in the EIA/TIA standards as the distance from the workstation outlet jack to the TR termination equipment patch panel/cross-connect port.

J. Provide adequate cable slack at each workstation outlet and the IDF/MDF termination equipment as follows:
   1. Workstation outlet
      a. 12 inches of copper cable slack.

K. Where cables are installed in conduit, the conduit system shall conform to the following:
   1. No section of conduit shall be longer than 100 feet between pulling points.
   2. No more than two 90 deg. Bends in a section of conduit between pulling points.
   3. Each section of conduit shall be labeled for length, destination closet and origination closet.
   4. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

L. At voice termination equipment at TR racks/backboards, voice backbone and station cables shall be terminated following the standard telephone color code unless otherwise indicated.

M. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

N. Lubricant – Utilize only lubricant specifically rated for the cable being installed.

3.3 Grounding – Not Applicable

3.4 Programming – Not Applicable

3.5 Identification/Labeling
A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. No labeling for any system which relies on room names/numbers as part of the equipment/cable labels shall be applied until the final building signage package with approved room names/numbers has been reviewed and incorporated. Labeling done based upon bid document room names/numbers prior to approved building signage package will not be accepted and may require the contractor to revise labeling at their expense.

C. Each cable, jack cross-connect and patch panel shall be labeled at every location where they are administered per TIA/EIA-606.

D. Both ends of data and telephone system cabling shall be tagged and identified utilizing a permanent cable marking system or other system as approved by the Owner / Engineer. DYMO style labels, cloth or plastic “numbers” or hand written labels WILL NOT BE ACCEPTED.

E. Station Cable, Room side - Utilize a three (3) syllable labeling scheme as follows:

1. Sample label for station cable / jack “TR5-01-33” (read as: Station cable, fed from TR-05, terminated in patch panel 01, terminated on jack number thirty three).
2. First syllable shall consist of a numeral following the letters “TR”. The numeral shall indicate the wiring closet “TR”, the jack and cable feed from (2 would be “TR-02”, 7 would be “TR-07”, etc.).
3. The second syllable shall consist of a numeral. The numeral shall indicate which patch panel in the wiring closet the cable is connected to.
4. The third syllable shall consist of a numeral to indicate which jack in the patch panel the cable is connected to.
5. Labels to be applied within 6 inches of termination.

F. Station Cable, Closet side - Utilize a three (3) syllable labeling scheme as follows:

1. Sample label for station cable / jack “143-01-33” (read as: Station cable, located in room 143, terminated in patch panel 01, terminated on jack number thirty three).
2. First syllable shall consist of a numeral. The numeral shall indicate the architectural room number of the room the jack is located in.
3. The second syllable shall consist of a numeral. The numeral shall indicate which patch panel in the wiring closet the cable is connected to.
4. The third syllable shall consist of a numeral to indicate which jack in the patch panel the cable is connected to.
5. Labels to be applied within 6 inches of termination.

G. Patch panels to have panel # / port # / room number for each terminated cable.

H. This contractor shall be responsible for creating/maintaining the numbering scheme as directed by the Owner.

I. Create a detailed records sheet for the station cabling including floor plans showing outlet locations and which jacks are in which outlet. Records shall indicate connection rack/backboard, patch panel / cross-connect and jack / port, at both ends, for each cable. Provide with O&M Manual.

J. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.6 Testing General
A. The Contractor shall be responsible for testing all installed structured cables including:

1. Voice and data station

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.

C. The Contractor shall be responsible for testing 10 percent of all installed data station cables, 10 percent of all installed voice station cables, where required to test a percentage of each cable type, the contractor shall choose the cables to test in such a manner as to provide a good cross sectional representation of the entire installed cabling plant. In such a manner, the Contractor shall avoid choosing all of the test cables from a single location or termination room.

D. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

E. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

F. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

G. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

H. The Owner / Architect / Engineer reserve the right to spot test 5 percent of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined that the installed cable plant does not agree with the documented test results, the contractor shall be responsible for re-testing the installed voice/data/fiber cabling plant and revising/updating all test documentation as required.

I. Instruments required for tests shall be furnished by the Contractor.

3.7 Testing Voice/Data Station

A. Each user voice and data station cable system shall be electronically verified. The voice / data system shall be tested in the permanent LINK (from the workstation outlet jack to the termination equipment patch panel port/cross-connect port) configuration. Each voice and data permanent LINK shall meet or exceed the EIA / TIA Solution Manufacturer’s specified parameters of components within each permanent LINK. The respondent’s test plan will specify the procedures for the following tests:

2. Length - Each cable pair is TDR scanned to determine each pair’s individual length. The test results are recorded in feet. The EIA/TIA specification limit of 90 meters is used to qualify the overall length of each circuit.
3. Attenuation - This test measures the loss or attenuation that each pair exhibits to determine whether or not high speed data packets will be discernible at their destination.
4. Induced Noise - The noise test measures the presence of external signals at three critical frequency ranges. The test results of each pair are recorded. The three ranges to be tested are as follows:
   a. Low Band (10Hz-150 KHz)
   b. Mid Band (150 KHz-16 Mhz)
c. High Band (16 Mhz-100 Mhz)

5. Resistance - a) Loop resistance, pair balance, pair-to-pair unbalance

6. Near End Crosstalk (NEXT) - The NEXT of each pair is measured as impacted by every other possible pair combination. The test sweeps the specification bandwidth to determine the worst case NEXT frequency for a particular pair. Both the NEXT value and occurring frequency are documented for each possible pair combination. The order of testing is as follows:
   a. Pair 1 & 2 to Pair 3 & 6
   b. Pair 1 & 2 to Pair 4 & 5
   c. Pair 1 & 2 to Pair 7 & 8
   d. Pair 3 & 6 to Pair 4 & 5
   e. Pair 3 & 6 to Pair 7 & 8
   f. Pair 4 & 5 to Pair 7 & 8

7. Test for Return Loss, Delay, Delay Skew, NEXT, PSNEXT, ELFEXT, PSELFEXT, ACR and PSACR shall be as required by the latest edition of EIA / TIA Level III tests and the latest edition of the Manufacturer’s/Source’s Channel Solution Program to verify adherence to these specifications of the cabling system.

8. All tests shall pass without any “marginals”.

B. The contractor shall provide independent 3rd party testing of 10 percent of all installed voice and data outlets. This independent testing shall be assembled in a separate binder and submitted along with the test reports in the O&M manual. Significant discrepancies in test results between the independent testing and the Contractor’s testing shall be addressed by the Contractor to the Engineer and the Owner’s satisfaction.

C. Provide a hard copy of the test results of each and every voice and data channel tested to the Owner. Documentation shall be in the following format:

1. Cable ID
2. Test parameter used
3. Date of test
4. Length
5. Pass / Fail result
6. Provide an electronic copy of the LINK/CHANNEL testing done with a cable analyzer and saved on removable media. Test results saved in a proprietary file type shall be included with software for reading the test results on the Owner’s computer system. Test results shall be verified by the Owner as part of the acceptance procedure. Provide with hard copies and a removable media containing the electronic files with the O&M Manuals.

3.8 Coordination With Communications Service Providers – Not Applicable

3.9 Training Requirements – Not Applicable

3.10 System Acceptance Requirements

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor’s expense prior to system acceptance.

3.11 As-Built Documentation

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer’s stamp.

C. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic...
sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

1. Termination cabinets, panels and enclosures

D. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

1. AutoCAD architectural floor plans at a scale of 0.125 inches = 1 foot-0 inches on 30x42 size sheets showing the location and label of each workstation outlet, IDF closet and MDF closet. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.

2. AutoCAD architectural floor plans at a scale of 0.25 inches = 1 foot-0 inches on 30x42, 24x36 size sheets showing the telecommunications equipment layout in each IDF closet and the MDF closet. This layout shall include the racks, backboards, cable tray, conduit sleeves, 120V power, etc. Each piece of equipment where labeled in the field shall have the corresponding label on these plans. These drawings shall be as-built conditions.

3. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

4. Rack elevations for all systems with rack mounted equipment. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such as patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.

E. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by media (fiber, copper) and by closet. Information must be included in O&M Manuals.

1. Copper Test Results
   a. Documentation shall be in the following format:
      1) Cable ID
      2) Test parameter used
      3) Date of test
      4) Length
      5) Pass / Fail result

F. Create a detailed records sheet for the station cabling including floor plans showing outlet locations and which jacks are in which outlet. Records shall indicate connection rack/backboard, patch panel / cross-connect and jack / port, at both ends, for each cable. Provide with O&M Manual.

G. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.12 Warranty

A. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a
written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. The entire voice / data station cabling system warranty shall be a listed cabling system solution from a single Manufacturer / Source. The system shall carry an industry standard, performance based warranty, by the manufacturer, for a period of at least 20 years on the horizontal cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of three (3) years from date of substantial completion.

C. The warranty shall not be affected by the use of power over Ethernet on any or all of the links.

D. The warranty shall not be affected by selected links required to have transition points from OSP to indoor where serving underground conduits to floor boxes. It shall be the Contractors responsibility to provide manufacturer's approved transition points to maintain system warranty on any affected runs.

3.13 Certification

A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.

PART 4 - UNIT PRICES

4.1 Unit Price Schedule

A. The Contractor(s) shall provide a unit price for the following items listed in this document. All unit prices shall reflect the total installed cost including labor, material, termination, testing, and any other incremental costs such as patch panel port:

1. Office Data Outlet with two (2) data ports and one (1) voice port, 200 feet cable length to wiring closet, patch cables on both ends, terminated, tested.
2. Classroom teacher outlet, 200 feet cable length to wiring closet (voice/data/CATV) and 50 cable length AV, patch cables both ends, terminated, tested.

END OF SECTION
PART 1 - GENERAL

1.1 Scope of Work

A. Work consists of the provision of new A/V equipment including:

1. Interactive Whiteboards
   a. Installed Units: Interactive white boards complete with wall/ceiling mounting hardware and connection to the broadband video distribution system and the local audio/video system as detailed on the drawings and as specified herein. Includes provision of all cabling, installation hardware and labor as required for a complete and functioning system. Provide a quantity of four (4). Install in locations selected by the Owner.

B. Included in the Scope of this Section:

1. Licenses, permits as may be applicable
2. Provision of submittal information
3. Installation in accordance with contract documents, manufacturers’ recommendations and applicable codes
4. Programming and configuration of control and signal processing software
5. Testing and adjustments, including documentation thereof
6. Provision of manuals
7. Maintenance and warranty services

C. Applicable References:

1. National Electric Code (NEC)
2. Underwriters Laboratories (UL)
4. Telecommunications Distribution Methods Manual (TDMM)

1.2 Quality Assurance

A. All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

B. All system components shall be UL listed.

C. Installation shall be in compliance with the National Electric Code and all other applicable codes.

D. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.

E. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.3 Contractor Qualifications

A. The A/V equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the A/V contractor to utilize a subcontractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall have on staff an Infocomm International-certified CTS-I A/V systems engineer/project manager responsible for overseeing the project and the lead technician (not installers) shall have a CTS certification.

1.4 Shop Drawings – Submit shop drawings including product data sheets and wiring diagrams per requirements in the General Conditions including the following:

A. Job specific system block diagram indicating the actual hardware required for the project including part numbers and interconnecting wiring requirements.

B. Complete and comprehensive Equipment Catalog Specification Sheets of each component provided, job specific.

C. 30x42 floor plans at a scale of not less than 1/8 inches =1 foot-0 inches showing location of all items of equipment. Drawings shall also indicate each location where 120 power is required.

D. Submittals that do not contain all the above information will be rejected.

PART 2 - PRODUCTS

2.1 Product Equivalency

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 Interactive White Board

A. Provide a fixed/mobile setup including Interactive White Board, LCD Projector, Software and all required cabling to connect board, projector and Owner furnished laptop/desktop PC or Macintosh. Coordinate computer platform with Owner.

B. Interactive Whiteboard – Unit shall provide a durable, low-reflective surface with electronic touch sensitivity for either projected or non-projected modes. Unit shall provide multiple electronic color pens, an electronic eraser and multiple function buttons for remotely activating mouse and keyboard controls. Unit shall include a portable floor stand with feet and locking casters.

C. Unit shall provide 4:3 aspect ratio, 77 inches minimum viewing area, equivalent to SMART Technologies series 680.

D. Interactive White Board Software – Software shall consist of drivers, recording, screen capture, and notebook features. The drivers activate the interactive features of the White Board while the notebook feature captures the session in a data file. The software must provide touch control so that activity on the touch-sensitive surface of the White Board can mimic standard mouse functions. The software must provide a recorder feature so that the entire session can be played back at a later time.
E. Manufacturers include Epson, model 695Wi.

F. Provide all required cables and USB/RJ-45 balun/converters as required to utilize the UTP data cable connection from the interactive whiteboard to the teacher PC.

PART 3 - EXECUTION

3.1 General Installation

A. Equipment shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all local, city, state and national codes.

B. Provide all hardware, framing members, etc. as required for mounting supports.

C. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.

D. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

3.2 Programming

A. Configuration and alignment of Interactive White Boards.

3.3 Tests

A. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer’s representative or equipment vendor; submit report indicating result to the Engineer.

3.4 Identification/Labeling

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both end and at each point where the cable is administered.

B. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 Training

A. Provide step-by-step user instructions identifying operator controls for normal use operations. This shall be included with the O&M manuals.

B. Training shall be performed by factory authorized representatives who have extensive backgrounds in the operation, use and programming or each system. Resumes of the system trainers shall be submitted to the Architect/Engineer for approval prior to scheduling of training. This training shall be planned and scheduled with the Owner. Training plan shall be pre-approved by the Engineer/Architect and shall include a review of the proposed syllabus.
C. All training shall be video-taped and burned to DVD at the completion of the project and turned over to owner with O&M manuals.

D. Training shall be on-site with the completed installation of the equipment unless specifically requested and approved by the Architect/Engineer. No training may be initiated until the system is complete, operational, programmed and approved by the Architect/Engineer.

E. The contractor shall arrange for the following end user training on the various A/V Systems.

1. Interactive Whiteboards – 12 hours Administrative training. 12 hours Educator training.

3.6 O & M Manuals

A. Copies of all approved shop drawings with the Engineer’s stamp, including comprehensive equipment list with manufacturer, model and quantities.

B. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of owner’s manuals must contain the proper software viewers for each document type.

1. Interactive White Board
2. Interactive LCD tablet
3. Classroom Document Camera
4. Classroom Response Systems

C. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

G. Provide statement of warranty with O&M Manuals.

3.7 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.
C. Where warranties on individual pieces of equipment exceed three (3) years, the guarantee period shall be extended to the warranty period of the particular items.

D. After completion of the work, the Contractor shall submit a Certificate of Warranty, stating commence and expiration dates and conditions of the warranty, for signature of both participating parties. Incremental warranties for complete portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor.

END OF SECTION
PART 1 - GENERAL

1.1 Scope of Work

A. The work described by this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of a battery-operated, synchronous clock system in operating condition as indicated on the drawings and/or specified herein.

B. Included in the Scope of this Section:

1. Licenses, permits as may be applicable
2. Provision of submittal information
3. Installation in accordance with contract documents, manufacturers’ recommendations and applicable codes
4. Programming and configuration of control and signal processing software
5. Testing and adjustments, including documentation thereof
6. Provision of manuals
7. Maintenance and warranty services

C. Applicable References:

1. National Electric Code (NEC)
2. Underwriters Laboratories (UL)
3. Telecommunications Distribution Methods Manual (TDMM)

D. In general, the conduit, outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed under the Electrical Contract. The entire responsibility for the system, its operation and function shall be that of the Electrical/Systems Contractor.

1.2 Description of Work

A. Expand a satellite time system including battery-operated receiver clocks and repeaters as shown on plans and defined in these specifications.

B. The system shall provide wireless synchronized precision time that is referenced to the US Government’s official NIST time standard (coordinated universal time) through GPS satellite or NTP internet connection. All clocks and the Central Sound System internal clock (if applicable) shall be synchronized with the NIST standard time.

C. Interconnection with Central Sound System:

1. Where interconnected to a microprocessor based two-way classroom communications system, the clock system shall have the ability to synchronize with the Central Sound System internal master clock. The “bell” scheduling program function shall be provided by the Central Sound System as a software application.

2. Where interconnected with a one-way, zoned public address system, the system shall have the ability to provide both selectable class change tones and the “bell” scheduling program function.
   a. Scheduling software shall be provided to setup and select programmable bell schedules. The ability to select alternate schedules and manually trigger audible tones shall be possible from the main office, either through manual selection or via software program.

3. Provisions shall be made to enable the following functions to be performed from the main school office:
   a. Selection of alternate bell schedules
b. Manual activation of the class change tone

4. With any system that requires a dedicated computer on which scheduling and/or control software resides, this Contractor shall provide the appropriate computer at no additional charge as an integral part of the system. Interconnection of same to the LAN shall be coordinated with the Contractor(s) responsible the voice/data and network electronics.

1.3 Quality Assurance

A. A System Contractor Qualifications: The system shall be supplied by an electronic systems contractor that is manufacturer-authorized and qualified in the proper installation, operation, programming and service of the system. The contractor must be located within 100 miles of the school and shall have completed, within the past two (2) years the satisfactory installation of at least three (3) systems of similar size and type as that herein specified. The contractor shall have a factory trained service department on call 24 hours a day, 365 days a year, to service the specified product.

B. Manufacturers’ Qualifications: The manufacturer shall have been regularly engaged in the manufacture of communication systems for at least five (5) years and be able to show at least five (5) satisfactory system installations, completed within the past two (2) years, of the similar size and type as that herein specified.

C. All system components shall be installed per all NEC codes and comply with all UL requirements.

D. Transmitter and receiver shall comply with Part 15 and Part 90 of FCC rules, as follows:
   1. This device may not cause harmful interference.
   2. This device must accept any interference received, including interference that may cause undesired operation.
   3. Transmitter frequency shall be governed by FCC Part 90.35.
   4. Transmitter output power shall be governed by FCC Part 90.257 (b).

E. Obtain operating license for the transmitter from the FCC if required by same.

F. System shall be installed in compliance with local and state authorities having jurisdiction.

1.4 Shop Drawings and Submittals - Submit the following for approval:

A. A complete equipment list, with manufacturers’ names, model numbers, and quantities of each item.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified. Data shall include
   1. Designations, dimensions, operating controls, electrical requirements, input/outlet configurations, operating controls, etc.
   2. Major components including all sub-assembly components (daughter cards, option cards, etc.) required to perform the specified functions.
   3. Any items of equipment which have features and/or functions that deviate from the specifications contained herein, shall have these deviations clearly called out by a separate attachment with the shop drawings specifically listing and detailing the deviation along with a justification. Deviations must be approved specifically in writing.

C. Operating License (if applicable): Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.
D. Qualifications: A statement of contractor’s qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

1.5 Final Documentation: All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner the following:

A. A complete as-installed equipment list
B. Operations instructions for each major item of equipment furnished
C. Manufacturer's warranty
D. Copy of applicable software
E. Copy of initial program schedule
F. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.6 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. Where manufacturers’ warranties on certain equipment exceed three (3) years, the guarantee period on that particular equipment shall match the extended warranty period.

1.7 Related Sections: Section 27 51 23 Central Sound System

PART 2 - PRODUCTS

2.1 General

A. All equipment items shall be new and unused.

B. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

C. Substitutions: Products specified herein by manufacturer’s name and model number are intended to establish a minimal level of quality, performance and function. Proposed substitute equipment by listed equal manufacturers shall be equal in all respects to the specified product.

2.2 Products

D. Repeater(s): Systems that require repeaters to provide wireless synchronization to all clocks shall be installed according to manufacturer’s recommendations in such a manner as to provide adequate coverage of the entire facility. Should repeaters need special provisions
such as dedicated electrical outlets or cabling, such provisions shall be the responsibility of this Contractor and coordinated with the other trades at no additional cost to the Owner.

E. Clocks

1. All clocks shall be battery operated. Battery life shall be five (5) years.
2. All clocks shall incorporate an internal FM antenna.
3. Upon losing the synchronizing signal from the transmitter, the clocks shall continue to function as accurate stand-alone quartz clocks until regaining reception of a valid time signal.
4. Provide 12 or 12.5 inch diameter clocks in classrooms.
5. Provide 15 or 16 inch diameter clocks in dining/auditeria, gymnasiums, auxiliary gymnasiums and multi-purpose rooms.
6. Provide 12 or 12.5 inch diameter double-faced clocks in corridors where shown on drawings.
7. Each clock shall have a white 12-hour dial face with a quartz crystal movement, red sweeping second hand.
8. Each clock shall be surface mounted and have an impact resistant molded polycarbonate case.
9. Provide protective Lexan shields or wire guards on all clocks located in gymnasium, locker rooms, and auxiliary gymnasiums.

F. Clock systems by Primex, to match existing model XR-80P.

G. Wiring: Provide wiring as recommended by the manufacturer to interconnect components as necessary to provide the specified functionality.

PART 3 - EXECUTION

3.1 Installation

A. GPS Unit: Coordinate installation of GPS receiver with work on the roof so that the bracket and related fasteners are watertight. Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant.

B. Transmitter: Locate transmitter where recommended by manufacturer, as high as possible and away from large metal objects such as filing cabinets, lockers or metal framed walls. Provide transmitters and/or repeaters in such quantities and locations as required to provide totally drop-free reception of all installed clocks. The Contractor may be required to perform a site survey in the completed building to determine final quantity and location of transmitters. The cost for this survey and any additional components shall be included in this contract.

C. WT Generator: Install the WT generator within close proximity to the Central Sound System Program Source Cabinet in the main office, and connect the audio output to the Central Sound System headend.

D. Verify that a PC having the specified minimum system requirements will be available for use in programming the tone schedules into the Wireless Tone generator or Transmitter.

E. Setup and program the initial bell schedule(s) as coordinated with the school administrative personnel

F. Install and set the time on clocks at all locations shown on the plans.

3.2 Final Checkout and Acceptance
A. The Contractor shall verify that the system is complete and fully operational before requesting final approval and before scheduling system demonstration.

B. This Contractor shall be available to demonstrate the operation and use of the system to the Architect/Engineer and to the owner's representatives and provide training to Owner's representative on replacing batteries and routine maintenance.

C. At the time of the demonstration, this Contractor shall furnish to the Owner two (2) complete record manuals.

D. Video record the instruction session. Provide two (2) copies as part of the O&M manuals.

E. Final acceptance of the system will be given upon completion of all of the above requirements.

END OF SECTION
ELECTRONIC DETECTION AND ALARM

28 31 00 B - FIRE DETECTION AND ALARM (ADDRESSABLE)

MAY, 2019
PART 1 - GENERAL

1.1 Fire Alarm System

1.1 This specification is for fire alarm initiation and notification devices and all other equipment as needed for the addition being provided under this project. Expand existing fire alarm system for coverage of the new building addition and renovation. New devices shall match old system and be compatible with old system.

1.2 Operation of existing system shall not be degraded by the addition of new devices.

1.3 System shall be a microprocessor based double supervised, closed circuit fire alarm system of modular design utilizing addressable technology for remote devices. Wiring shall be Class "B" for signaling and notification circuits. Smoke detectors shall be analog, addressable units with control panel adjustable sensitivity. All units of equipment shall be labeled by Underwriters' Laboratories for fire alarm signaling use and shall comply with UL 864 Ninth Edition.

1.4 The fire alarm system and installation shall be in compliance with local, city, state, NFPA, ADAAG and IBC Codes.

A. Operation of any addressable manual or automatic fire alarm initiating device shall initiate the following:

1. Sound a Code-3 temporal pattern master coded audible fire alarm signal for a minimum of two cycles and illuminate fire signal lights in a synchronous mode until alarms have been silenced at the main fire alarm system control panel or at a remote operator's control panel by means of the "alarm silence" switch or the device returned to normal and a "reset" switch is manually actuated.

2. Display alarm condition on integral alphanumeric LCD displays in the control panel(s), and remote annunciator(s), indicating the alarming device and its location. Each manual and automatic alarm initiating device shall be individually addressed.

3. Print the assigned English language message and activate control-by-event functions, with time and date, for the monitored point in alarm at the printer at the control panel.

4. Initiate a separate trouble and alarm signal for connection to the municipal fire department or remote monitoring service organization via leased telephone lines or as directed by the Owner.

5. Provide all programming, technician time, wiring etc. to make a complete and operational system.

B. Provide all programming, technician time, wiring etc. to make a complete and operational system.

C. In the event of operating power failure or an open or a grounded circuit in the system, a trouble signal and trouble LED shall be activated until the system is restored to normal. The trouble event shall be recorded within the control panel historical trouble log, and printed on the system printer (when applicable). The trouble signal may be silenced by means of a button located on the control panel operator's interface. Upon restoration of the system to normal condition, the trouble indicators shall automatically extinguish.

D. Supervised Monitoring

1. Operation of the supervisory service of the fire alarm system shall provide for the central monitoring and programmed control of various pieces of equipment and/or systems. These pieces of equipment shall be interfaced with the fire alarm system via dry contacts and supervised circuitry utilizing individual addressable modules (Monitor IAM) and...
programmable relay control module (Relay IAM) that are connected to the fire alarm systems data wiring.

2. The fire alarm supplier shall provide individual programming for each monitor point and control point for customized response. As a minimum, programmed response shall include the ability to sound the system trouble alarm at any or all operator control panels and annunciators, display unique alpha-numeric messages, re-initiate a silenced alarm that has not been corrected after a programmed time and initiate a higher alarm status for designated alarms that have not been acknowledged in a programmed time.

1.5 Emergency Control Functions and Interfaces

A. Operation of any addressable manual or automatic fire alarm initiating device shall interface with the components described herein.

B. HVAC Systems

1. Shut-down air handling unit fans serving that respective fire zone whenever the alarm occurs. Each air handling unit shall have a separate zone with separate signal for this use. The unit zone shall include all smoke detectors and all high limit stats associated with that unit. Provide a set of remote contacts for each air handling unit zone at location as coordinated with the ATC Contractor. Provide control panel mounted H-O-A / “softkey” override switch(es) to permit continuous operation of fan(s) during test of the fire alarm system.

C. Door Controls

1. Release all electro-magnetic door holders.
2. Security Door System Interface
   a. Provide fire alarm control interface with indicated doors to deactivate door controls (i.e., unlock doors) for a fire alarm condition. Verify programming of each door with fire alarm zones with Engineer prior to installation.
   b. Refer to drawing for quantity and location of door devices to be interfaced.

PART 2 - PRODUCTS

2.1 Equipment shall be as manufactured by Siemens, Fire Alarm Division. Equipment supplier shall have a service organization within 50 miles of the project site. All material and/or equipment necessary for proper operation of the system not specified or described herein shall be deemed part of these specifications.

2.1 Remote Fire Alarm System Components

A. Manual stations shall be addressable communicating devices, shall have a red finish and shall be non-coded, single action with breakglass operation (glass rod not required to reset station), surface mounted with keyed reset switch. Siemens #MSI-10B.

B. Protective shields for manual stations shall be tamperproof, clear Lexan covers with red frames that are designed to mount over manual pull stations. When the Lexan cover is lifted to gain access to the manual station, a battery powered horn that is mounted integrally in the protective shield's red frame sounds a loud, local, audible signal until the cover is returned to its normal, closed position. #STI-1100.

C. Programmable relay control module shall be an individual addressable module used for control of auxiliary functions such as elevator control, door release, smoke damper shutdown, air handling unit shutdown, etc

D. Fire signal lights (strobe lights) for synchronized operation shall provide visual indication of all alarms and shall illuminate in a flashing mode whenever system is in alarm state. Fire signal
lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 30 candela in all other areas unless specifically designated as 75 candela or 110 candela on the drawings. Surface mount signal lights on walls where shown on the drawings. Lens shall be installed on a red back plate labeled “FIRE” and shall produce 1 flash per second. Wheelock #STR.

E. Combo horns with fire signal lights (strobe lights) for synchronized operation shall provide both audible and visual indication of all alarms and shall illuminate in a synchronized flashing mode whenever system is in alarm state. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 30 candela in all other areas unless specifically designated as 75 candela or 110 candela on the drawings. Surface mount signals on walls where shown on the drawings. Lens shall produce 1 flash per second. Horns shall be supplied with a red grille / cover and labeled “FIRE” and shall have field selectable output levels of 90, 95 and 99 dBA at 10 foot (based on UL 464 reverberant test requirements). Horn operating power levels shall be set initially at 90 dB and adjusted up or down as required for proper sound coverage during the final checkout. Power calculations shall be made using the current draw for these units operating at 99 dB. Wheelock #HSR.

F. Surface mounted fire alarm devices mounted on walls - such as manual stations, bells, horns, chimes, fire signal lights, etc. shall utilize finished backboxes. These backboxes shall be red metal and shall be field punched for conduit entrance and shall not employ stamped K-O construction.

G. Zone adaptor module (ZAM) shall be an addressable module for interfacing non-addressable equipment to the fire alarm system. Siemens TRI Series.

H. Magnetic door holders shall be voltage selectable for 24 VDC or 24/120 VAC operation. Flush, semiflush or surface wall mounted as required. Floor mount models for single door or double door applications where required. Verify type of each with architect prior to rough-in and provide accordingly.

I. Photo-electric type, addressable duct mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at .5% to 3.7% light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individually adjustable through the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. The detector shall contain an integrally mounted LED pilot lamp that indicates detector status. Siemens FDBZ492 housing with FP-11 detector.

J. Notification appliance power extender control panels shall be provided where shown on the drawings, shall be completely supervised from the main fire alarm panel and shall be capable of powering additional visual alarm signals and/or audible alarm signal circuits. Each panel shall include supervisory modules, power supplies, batteries and chargers. At the Contractor's option, additional extender panels may be utilized. Coordinate exact locations of these additional remote panels with the Architect/Engineer during the submittal phase. Operating power (120V) shall be supplied from the nearest panel. Wheelock #FF8 panel with accessories.

2.2 The fire alarm supplier shall submit for approval with shop drawings, schematic and point to point wiring diagrams showing all manual and automatic devices, control panels, sounding devices, conduit sizes, number and size of wires, etc. Shop drawings shall include calculations for sizing of signal power supplies, voltage drop calculations for audible and visual signal circuits (including provisions for future devices), speaker amplifiers and standby batteries. Voltage drop calculations will be based on each strobe drawing 110% of operating current and each audible device drawing 120% of operating current to allow for future devices. SHOP DRAWINGS WILL BE REJECTED UNLESS THE SUBMITTAL INCLUDES ALL THIS REQUIRED INFORMATION. At completion of the project, the wiring diagrams shall be revised “as-built” and included as part of the maintenance.
manuals. The fire alarm supplier shall also furnish a hard copy printout of each detector's address, operating routines, etc. as part of the as-built drawings. Additionally, the supplier shall include an electronic copy (floppy disks or data cassettes) of the system's operating program with the as-builts for the Owner's records.

2.3 The Contractor or his fire alarm supplier/installer shall submit shop drawings, after the Architect's and Engineer's approval, to the State Fire Marshal's Office and Factory and Building where applicable for their review and approval; where buildings are not under the jurisdiction of the State Fire Marshal, the shop drawings shall be submitted to the local fire official for review and approval. If the fire alarm supplier / installer needs sealed documents for submittal to the inspection authority, the Engineer will seal and sign one original set of documents after the shop drawings have been approved.

PART 3 - EXECUTION

3.1 Submittals

A. The fire alarm supplier shall submit for approval with shop drawings, floor plans, schematic and point to point wiring diagrams showing all manual and automatic devices, control panels, sounding devices, conduit sizes, number and size of wires, etc. Shop drawings shall include calculations for sizing of signal power supplies, voltage drop calculations for audible and visual signal circuits (including provisions for future devices), speaker amplifiers and standby batteries. Voltage drop calculations will be based on each strobe drawing 110 percent of operating current and each audible device drawing 120 percent of operating current to allow for future devices. Submittal shall include copies of personnel certification as required in PART 3. SHOP DRAWINGS WILL BE REJECTED UNLESS THE SUBMITTAL INCLUDES ALL THIS REQUIRED INFORMATION.

B. At completion of the project, the floor plans and wiring diagrams shall be revised “as built” and included as part of the maintenance manuals. The fire alarm supplier shall also furnish a hard copy printout of each detector's address, operating routines, etc. as part of the as-built drawings. Additionally, the supplier shall include an electronic copy (in a digital media format acceptable to the Owner) of the system's operating program with the as-builts for the Owner's records.

3.2 Follow NFPA 72 and manufacturer's instructions regarding mounting, wiring and testing system. Installer(s) shall meet project's respective State and local Municipality requirements for certification and as a minimum, have one installer certified as a NICET Level 2. In addition, the fire alarm system supplier shall have on staff, one NICET Level 3 certified individual and be an U.L. certified company.

3.3 Surface mounted fire alarm devices (when specifically permitted) mounted on walls - such as manual stations, bells, horns, chimes, fire signal lights, etc. shall utilize finished backboxes. These backboxes shall be red metal and shall be field punched for conduit entrance and shall not employ stamped K-O construction. Note that all devices in public or finished areas shall utilize recessed mounted boxes unless noted otherwise.

3.4 Coordinate door holder equipment connections with hardware supplier and supply necessary power supply from main control panel. Door holders shall not be maintained by integral control unit back up battery.

3.5 Duct mounted smoke detectors shall be located per U.L. and manufacturer's guidelines to permit easy access for maintenance and testing. Provide access panels where required. Assure accessibility to the entire assembly.

3.6 Provide protection, such as wire guards, which are listed for the specific use on all fire alarm devices within gyms, locker rooms, multi-purpose rooms and other areas subject to mechanical damage.
3.7 Provide a smoke detector at the location of each fire alarm control panel (main panel, auxiliary control panels and remote annunciators) and extend into the system.

3.8 Coordinate locations of any additional remote panels (i.e., transponders, extenders, etc.) with the Engineer during the submittal phase. Provide 120 volt power circuit to each remote panel.

3.9 Wiring, #14 AWG minimum, shall be installed in accordance with manufacturer's wiring diagrams, recommendations and in compliance with practices set forth by local, state and national fire codes. Color code and tag all wires at all junction points. #18 AWG conductors may be utilized when installed as a multi-conductor cable with an overall protective jacket when approved by manufacturer. All fire alarm system wiring shall comply with NEC Article 760.

A. All wiring shall be tagged and labeled to correspond with the final record drawings.

3.10 All wiring shall be installed in conduit; conduit system shall be independent of all other systems.

3.11 The following wiring and conduit shall be included in the fire alarm system work in addition to that indicated above:

A. Empty conduit with pullwire from the digital communicator to the main telephone backboard. Telephone wiring from the telephone backboard to the digital communicator is the Contractor’s responsibility. Assist in making final connections at the digital communicator and verify transmission to and receipt by the Central Station.

B. From fire alarm panel, duct mounted smoke detector, or control relay module to each air handling unit and exhaust fan for shutdown.

C. From fire alarm panel or control relay module to each EP switch/control panel in ATC system for closing smoke dampers or smoke removal systems.

D. From fire alarm panel to electro-mechanical door holders. Coordinate power supply requirements with hardware supplier.

E. Wiring to supervisory monitor and control points such as generator alarm wiring or fire pump alarm wiring.

F. Provide surge suppressors on all wiring which extends outside the building by either underground or overhead wiring to other buildings or remote device locations. The fire alarm supplier shall provide suppressors that are compatible with their system.

3.12 System Testing

A. Upon completion and before acceptance, system performance shall be demonstrated in the presence of the Architect that all specified functions are accomplished and that response is accomplished from all initiating and indicating devices. Provide step-by-step user instructions with graphics identifying operator controls for normal user operations such as silencing of alarms, resetting of system, locking and unlocking controlled doors, etc. Each normal operation shall be on a separate page and all pages shall be laminated for durability and assembled in a three ring "operators manual". This manual is in addition to shop drawings and maintenance manuals.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer’s representative or equipment vendor; submit report indicating results to the Architect. This testing shall be done with the building HVAC systems in operation and the manufacturer’s representative shall field check the dBA readings in accordance with levels established by NFPA 72. During this checkout period, adjust audible device output levels as needed.
3.13 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M manuals.

B. During the warranted operation, provide an annual inspection (for a total of 3). This work is inclusive with the warranty and shall be performed during regular working hours, Monday through Friday, excluding legal holidays, as coordinated with the Owner. Provide an inspection report to the Owner.

C. Provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system components operation or the loss of the head-end equipment which renders the system un-useable. Provide an on-site authorized factory technician within 24 hours if required.

D. If equipment components cannot be repaired within 24 hours of service visit, provide “loaner” equipment components to the Owner at no charge.

3.14 Base bid includes three (3) additional combination audible/visual alarm signals 75 cd, and one (1) additional duct mounted smoke detectors, complete with installation, power supplies, amplifiers, and fifty (50) feet of conduit with circuitry per device. These additional base bid devices shall also include any related submissions to the AHJ, revised “as-built”, related system programming and revised Owner electronic copy. The audible/visual signals and smoke detection shall be added where designated by the Engineer at the time of final acceptance.

END OF SECTION