Project Manual Set No. _____

VOLUME 2 OF 2

2023 CAPITAL PROJECT - PHASE III
HIGH SCHOOL-AIR CONDITIONING

NEWARK VALLEY CENTRAL SCHOOL DISTRICT

OWNER:
NEWARK VALLEY CENTRAL SCHOOL DISTRICT
68 WILSON CREEK ROAD
NEWARK VALLEY, NEW YORK 13811

SED PROJECT NUMBERS:

High School: 60-04-02-04-0-007-023

SED Approval Dates:
January 23, 2026

KEYSTONE ASSOCIATES
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Project No.: 1823.24221.1.3 December 12, 2025

2023 CAPITAL PROJECT - PHASE III
HIGH SCHOOL AIR CONDITIONING

NEWARK VALLEY CENTRAL SCHOOL DISTRICT

THE UNDERSIGNED CERTIFIES THAT TO THE BEST OF HIS KNOWLEDGE, INFORMATION AND BELIEF, THE PLANS AND SPECIFICATIONS ARE IN ACCORDANCE WITH APPLICABLE REQUIREMENTS OF THE New York STATE UNIFORM FIRE PREVENTION AND BUILDING CODE, THE STATE ENERGY CONSERVATION CONSTRUCTION CODE AND CONSTRUCTION STANDARDS OF THE EDUCATION DEPARTMENT.

EXP. 08/31/2026

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68 WILSON CREEK ROAD
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EXP. 11/30/2028

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EXP. 04/30/2027

DOCUMENT 00 01 10

TABLE OF CONTENTS

VOLUME 1

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

INTRODUCTORY INFORMATION

PROCUREMENT REQUIREMENTS

PROCUREMENT FORMS AND SUPPLEMENTS

CONTRACTING REQUIREMENTS

SPECIFICATIONS GROUP

GENERAL REQUIREMENTS SUBGROUP

DIVISION 01 - GENERAL REQUIREMENTS

VOLUME 2

DIVISION 03 - CONCRETE

DIVISION 05 - METALS

DIVISION 06 - WOOD, PLASTICS AND COMPOSITES

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

DIVISION 09 - FINISHES

DIVISION 12 – FURNISHING MANUFACTURERS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

DIVISION 26 - ELECTRICAL

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY
Section 28 31 11 Fire Alarm System Renovations

DRAWING LIST

-	COVER
SED100	BASEMENT FLOOR CODE PLAN
SED101	FIRST FLOOR CODE PLAN
SED102	SECOND FLOOR CODE PLAN
S101	STRUCTURAL ROOF FRAMING, DETAILS & NOTES
A100	FIRST FLOOR DEMOLITION PLAN
A101	FIRST FLOOR DEMOLITION PLAN
A102	FIRST FLOOR DEMOLITION PLAN
A103	SECOND FLOOR DEMOLITION PLAN
A104	SECOND FLOOR DEMOLITION PLAN
A105	SECOND FLOOR DEMOLITION PLAN
A106	FIRST FLOOR PROPOSED PLAN
A107	FIRST FLOOR PROPOSED PLAN
A108	FIRST FLOOR PROPOSED PLAN
A109	SECOND FLOOR PROPOSED PLAN
A110	SECOND FLOOR PROPOSED PLAN
A111	SECOND FLOOR PROPOSED PLAN
A700	PROPOSED ROOF PLAN AND DETAILS
M001	SYMBOLS, LEGENDS, ABBREVIATIONS AND GENERAL NOTES
M002	MECHANICAL SCHEDULES
M003	MECHANICAL SCHEDULES
M004	MECHANICAL SCHEDULES
M201	BASEMENT MECHANICAL REMOVAL PLAN – PARTIAL AREA 1
M202	FIRST FLOOR MECHANICAL REMOVAL PLAN – AREA 1
M203	FIRST FLOOR MECHANICAL REMOVAL PLAN – AREA 2
M204	FIRST FLOOR MECHANICAL REMOVAL PLAN – AREA 3
M205	SECOND FLOOR MECHANICAL REMOVAL PLAN – AREA 1
M206	SECOND FLOOR MECHANICAL REMOVAL PLAN – AREA 2
M207	SECOND FLOOR MECHANICAL REMOVAL PLAN – AREA 3
M208	ROOF MECHANICAL REMOVAL PLAN – AREA 1
M209	ROOF MECHANICAL REMOVAL PLAN – AREA 2
M210	ROOF MECHANICAL REMOVAL PLAN – AREA 3
M301	FIRST FLOOR DUCT PLAN – AREA 1
M302	FIRST FLOOR DUCT PLAN – AREA 2
M303	FIRST FLOOR DUCT PLAN – AREA 3
M304	SECOND FLOOR DUCT PLAN – AREA 1
M305	SECOND FLOOR DUCT PLAN – AREA 2
M306	SECOND FLOOR DUCT PLAN – AREA 3
M307	ROOF MECHANICAL PLAN – AREA 1
M308	ROOF MECHANICAL PLAN – AREA 2

CONCRETE

DIVISION 03

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Extent of concrete work is shown on drawings.

B. Related Requirements:
   1. Division 01 Section "Special Inspection and Testing"

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement or Portland-Limestone cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, or other pozzolans. Materials subject to compliance with requirements.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Cementitious materials
   2. Admixtures
   3. Form materials and form-release agents
   4. Steel reinforcement and accessories
   5. Grout
   6. Curing compounds
   7. Floor and slab treatments
   8. Post-installed anchors
   9. Related materials

B. Design Mixtures: For each concrete mixture submit field or trial mixture test records used to document that proposed mixture will achieve the average compressive strength and other specified properties in PART 2. Mix design submitted for review shall conform to the requirements of ACI 301.
   1. Submit list of ingredients used for the composition of the design mixtures, and their proportions.
   2. Indicate amounts of mixing water to be withheld for later addition at Project site.
   3. Material Test Reports: For the following, from a qualified testing agency:
      a. Aggregates
      b. Cementitious Materials
   4. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Mix

design submitted for review shall be representative of the concrete materials currently being used.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Comply with CRSI – Manual of Standard Practice showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement, mechanical connections, tie spacing, hoop spacing. Include special reinforcement required for openings through concrete structures.
   1. Reproduction of contract drawings for use as shop drawings is not permitted.
   2. Submit erection drawings in Portable Document Format (pdf) Contractor is responsible for making copies of reviewed shop drawings and distributing them to subcontractors.
   3. AutoCAD and/or Revit Structure files of structural drawings will be available for use subject to acceptance of a Disclaimer.
   4. Contractor shall leave a 3-inch high by 4-inch wide blank space in the title block or on cover page in which the review stamp will be placed.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 and ASTM C 685 requirements for production facilities and equipment.
   1. Batch tickets are required to be provided for each batch of concrete produced and delivered.

B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents.
   1. ACI 117 – 2010, "Specifications for Tolerances for Concrete Construction and Materials."
   2. ACI 301 – 2010, "Specifications for Structural Concrete."
   3. ACI 302.1 – 2004, "Guide for Concrete Floor and Slab Construction."
   4. ACI 308.1 – 2011, "Specification for Curing Concrete."
   5. ACI 318 – 2014, "Building Code Requirements for Structural Concrete."
   6. ACI 347 – 2014, "Guide to Formwork for Concrete."

D. Reference Standards:
   1. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice," 2009.
   2. Building Code of New York State, 2020.
   3. New York State Department of Transportation (NYSDOT) Standard Specifications, 2018.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
   1. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated for concrete mixture design and material test reports.

a. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I.
b. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Plywood, metal, or other suitable form-facing panels that provide continuous, true, and smooth as-cast concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

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.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

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.

2.2 STEEL REINFORCEMENT

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

2.3 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," of greater compressive strength than concrete and as follows:
1. For concrete surfaces exposed to view, where legs of wire bar support contact forms, use CRSI Class 1 plastic-protected steel wire, CRSI Class 2 stainless-steel, or other suitable non-ferrous supports.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials of the same type, brand, and source throughout Project:
1. Portland Cement: ASTM C 150, Type I/II.
2. Fly Ash: ASTM C 618, Class F or C, with loss on ignition less than 6 percent.
3. Slag Cement: ASTM C 989, Grade 100 or 120.
4. Blended Hydraulic Cement (Portland Limestone Cement): ASTM C 595 Type IL.

5. Ground Glass Pozzolan: ASTM C1866, Type GS or Type GE.

B. Aggregates:
   1. General: Aggregates shall have hard, angular, strong, clean, uncoated, durable particles and shall be free of injurious amounts of thin elongated pieces, mica, clay, silt, or organic matter. Aggregates shall be from a single local source with prior record of acceptable use. Tests and analysis shall be no more than 90 days old.
   2. Normal-Weight Aggregates: Aggregates shall comply with ASTM C 33.
      a. Fine aggregate shall be natural sand or stone screenings, free of materials with deleterious reactivity to alkali in cement. The fineness modulus shall not vary by more than 0.20 throughout the work.
      b. Coarse aggregate shall be crushed stone or crushed gravel meeting gradation requirements for ASTM C 33.
         1) Provide the largest size of aggregates practical within the gradation limits referenced in paragraph "Concrete Mixtures for Building Elements" below.
         2) Crushed gravel shall comply with NYSDOT Standard Specifications Section 703-02.
      c. ASTM C 33 Class Designation for Coarse Aggregates:
         1) Exterior exposed concrete subject to frequent wetting – Class 4S.
         2) Other concrete – Class 3S.
   3. Material Test Reports: Submit results from ASTM C 40, C 88, C 117, C 123, C 136, C 142, C 227, C 289, and C 1260 tests for the aggregates to be used in each concrete mix.

C. Water: ASTM C 94 and potable.

D. Admixtures:
   1. 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.
      a. Water-Reducing Admixture: ASTM C 494, Type A.
      b. Retarding Admixture: ASTM C 494, Type B.
      c. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
      d. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
      e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
      f. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
   2. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.

2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.
   1. Products: Subject to compliance with requirements, available products that may be incorporated in the work include, but are not limited to, the following:
      a. "Masterflow 928" by BASF Building Systems
      b. "SikaGrout 328" by Sika
      c. "High Strength Grout" by Five-Star Products

2.6 EPOXY ADHESIVE FOR ANCHORAGE TO CONCRETE

A. Two component, high solids, moisture tolerant structural epoxy adhesive conforming with ASTM C881. See Drawings for fastener materials and additional requirements.
   1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
      a. "HIT RE-500" by Hilti
      b. "Set-3G" by Simpson Strong-Tie
      c. "PE 1000 +" by Powers Fasteners
      d. "Epcon G5" by ITW Red-Head

2.7 CURING MATERIALS

A. Semi-Transparent Membrane-Forming Curing Compound: Liquid type, water based, VOC compliant, membrane-forming curing compound complying with ASTM C 309, Type 1D, Class B, containing fugitive red dye in adequate proportions to remain visible on concrete surface for 24 hours. Moisture loss not more than 0.55 kg/m^2 in 72 hours. Compound shall be removable to not affect bond of applied floor finish. Material shall be semi-transparent to aid in placement.
   1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
      a. "1100-Clear" by W.R. Meadows
      b. "Kurez DR-100" by Euclid
      c. "Resin Cure with Dye J11WD" by Dayton Superior

2.8 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, Portland cement or blended hydraulic cement as defined in ASTM C 595.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109.

2.9 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. Concrete mix designs shall conform to the requirements of ACI 301-10, including, but not limited to the following:
   1. Mix designs based on field strength test records:
      a. If there are 15 or more consecutive field strength test records for the specified class of concrete, or within 1,000 psi of the specified class, within the time limits specified in ACI 301, the sample standard deviation shall be calculated and the "required average compression strength" shall be determined as specified in ACI 301. If the average of all test results is greater than the "required average

compression strength", the concrete mix proportions can be determined from the proportions of the samples used for the field strength records.

1) Tests must have been performed within the past 12 months and must span a period of at least 60 days.

b. If there are 10 or more consecutive field strength test records using similar materials, within the time limits specified in ACI 301, the "required average compression strength" shall be determined from Table 4.2.3.3.b specified in ACI 301. If the average of all test results is greater than the "required average compression strength", the concrete mix proportions can be determined from the proportions of the samples used for the field strength records.

1) Tests must have been performed within the past 24 months and span a period of at least 60 days.

2. Mix designs based on laboratory trial mixture test data:

a. If a sufficient number of qualifying field strength test records are not available that meet the "required average compression strength", the concrete mix proportions shall be determined by laboratory trial mixture test data, as specified in ACI 301. The "required average compression strength" shall be determined from Table 4.2.3.3.b specified in ACI 301.

b. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

c. Tests must have been performed within the past 24 months.

B. Cementitious Materials:

1. Use cementitious materials of the same brand and type and from the same manufacturing plant as those used in establishing the concrete mix design.

2. Use fly ash, slag cement, or ground glass pozzolan as needed to reduce the total amount of Portland cement or blended hydraulic cement, which would otherwise be used, by not less than 20 percent. Notify concrete floor finishers of floor slab concrete containing fly ash or slag cement.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Use aggregates from the same source and of the same size range as those used in establishing the concrete mix design.

E. Admixtures: Use admixtures of the same brand and type as those used in establishing the concrete mix design. Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.

2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete and concrete with a water-cementitious materials ratio below 0.50.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules:

1. Concrete containing fly ash or slag cement must achieve stated compressive strength by 56 days.

Mix Label	Use	Minimum 28-Day Compressive Strength, psi	Exposure Class	Maximum Aggregate Size	Maximum Water/ Cement Ratio	Air Content ±1.5% at Delivery
STR305	Interior Slabs	3,000	F0	1-1/2"	0.50	-

B. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows: 4" maximum.

2.11 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 90 minutes to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
   2. Remove excess water and debris from trucks before batching. Account for wash water remaining in truck, per ASTM C 94, in measurement of water per batch or completely empty truck drum of wash water prior to adding batch materials to truck.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
   1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
   2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
   3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

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:
   1. Class A, 1/8 inch for smooth-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Do not use rust-stained steel form-facing material.

F. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

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

H. 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. Formwork 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.
   1. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. 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 barrier during reinforcement placement and concreting operations. Repair damage and reseal vapor barrier 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.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

C. Do not exceed specified water-cementitious materials ratio.

D. 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. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
      a. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, until placement of a section is complete.
   1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. 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.

3.5 FINISHING FORMED SURFACES

A. General: Remove all ties and patch holes, including those below grade.

B. Smooth-Formed Finish: 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, or to be covered with a coating or covering material applied directly to concrete.

3.6 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. Bleed water may be delayed in slabs containing fly ash or slag cement. Notify floor finishers of all concrete slabs containing fly ash or slag cement.
   1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

2. After screeding, consolidating, and leveling concrete slabs, work surface only after it is ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operations of power-driven floats, or both. Bleed water will be retarded in concrete containing fly ash or slag cement. Begin floating or troweling operation only after bleed water has come to the surface. Check and level surface plane to minimum local F number tolerances of F_F 19 – F_L 13. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

B. Trowel Finish: 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.

3.7 MISCELLANEOUS CONCRETE ITEM INSTALLATION

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. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.8 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. Prevent construction vehicle traffic from traveling on concrete slabs until curing is complete and concrete has achieved its 28-day design compressive strength. Scissor lifts and similar personnel hoists may be used on slabs only after concrete has achieved at least 75 percent of its 28-day compressive strength.

C. Begin curing procedures before concrete surface has dried. Continue curing for not less than 7 days. Avoid rapid drying at end of final curing period.

D. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar 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 with methods specified below, as applicable.

E. Unformed Surfaces (Interior Concrete): Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs and other surfaces. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

3.9 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. 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.

C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations 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 1/2 inch at perimeter of repair area. Use as few cuts as possible, keeping angles at least 90 degrees with no re-entrant (inside) corners. Make edges of cuts perpendicular to concrete surface. Chip concrete within perimeter to solid concrete and provide an exposed aggregate surface condition complying with ICRI CSP-6 or rougher. Flush repair area with clean water and allow to dry to saturated-surface-dry condition. Place, compact, and finish to blend with adjacent finished concrete. Cure patch area in accordance with procedures specified for unformed cast-in-place concrete.
   2. Repair defects on surfaces exposed to view 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.

D. 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, whether caused by finishing process or slab curl, by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   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. Use as few cuts as possible, keeping angles at least 90 degrees with no re-entrant (inside) corners. Make edges of cuts perpendicular to concrete surface. Chip concrete within perimeter to solid concrete and provide an exposed aggregate surface condition complying with ICRI CSP-6 or rougher. Flush repair area with clean water and allow to dry to saturated-surface-dry condition. 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. Flush repair area with clean water and allow to dry to saturated-surface-dry condition. 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.

E. Repair materials and installation not specified above may be used, subject to the Structural Engineer of Record's approval.

END OF SECTION

METALS

DIVISION 05

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Extent of structural steel work is shown on Drawings, including schedules, notes and details to show size and location of members, typical connections, and type of steel required.

B. Source Quality Control: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements. Promptly remove and replace materials or fabricated components which do not comply.

C. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work. Promptly notify Architect whenever design of members and connections for any portion of structure are not clearly indicated.

D. Related Sections:
   1. Division 01 Section "Special Inspection and Testing."
   2. Division 09 painting Sections for finish painting requirements.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.4 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of 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.

1.5 SUBMITTALS

A. Shop Drawings: Show fabrication of structural-steel components and erection drawings showing assembly of components with piece marks clearly noted.
   1. Reproduction of Contract Drawings for use as shop drawings is not permitted.
   2. Submit electronic fabrication shop drawings in Portable Document Format. Contractor is responsible for making copies of reviewed shop drawings and distributing them to sub-contractors.

3. AutoCAD and/or Revit Structure files of structural drawings will be available for use subject to acceptance of a Disclaimer.
4. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
5. 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.
6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
7. Shop paint.
8. Contractor shall leave a 3-inch high by 4-inch wide blank space in the title block or on the cover page in which the review stamp will be placed.

B. Product Test Reports: For the following:
1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Post-Installed anchors.
3. Shop primers.
4. Nonshrink grout.

C. Welding Certificates: Welders must be AWS-certified for weld types and positions required.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Mill test reports for structural steel, including chemical and physical properties.

1.6 QUALITY ASSURANCE

A. Comply with applicable provisions of the following specifications and documents:
1. AISC 303 – 2016, "Code of Standard Practice for Steel Buildings and Bridges."
2. AISC 360 – 2016, "Specification for Structural Steel Buildings."
3. AWS D1.1 – 2015, "Structural Welding Code – Steel."
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts", 2014 Edition.
5. Building Code of New York State, 2020.

B. Special Inspections: See Section 01 45 33 - "Special Inspection and Testing" for a description of the special inspections and testing to be paid for by the Owner and for the extent of the Contractor's responsibilities with regard to the Special Inspections and Testing program.

1.7 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 sealing of containers.

2. Clean and relubricate bolts and nuts that become dry or rusty before use.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' 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.

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL MATERIALS

A. Metal Surfaces, General: For fabrication of work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.

B. W-Shapes and WT-Shapes: ASTM A 992.

C. Channels, Angles, M, S-Shapes and ST-Shapes: ASTM A 36.

D. Plate and Bar: ASTM A 36.

E. Hollow Structural Sections: ASTM A 500, Grade B.

F. Steel Pipe: ASTM A 53, Type E, Grade B.
1. Weight Class: Standard unless noted otherwise on the drawings.

G. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM F 3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, or ASTM A 194, Grade 2H, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM F 3125, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, or ASTM A 194, Grade 2H, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

C. Post-Installed Anchors:
1. Epoxy Adhesive for Anchorage to Concrete or Grouted Masonry: Two component, high solids, moisture tolerant structural epoxy adhesive conforming with ASTM C881. See Drawings for fastener materials and additional requirements.

a. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
1) "HIT RE-500" by Hilti
2) "Set-XP" by Simpson Strong-Tie
3) "PE 1000 +" by Powers Fasteners
4) "Epcon G5" by ITW Red-Head

2. Expansion Anchor for Anchorage to Concrete, Solid Masonry or Grouted Masonry: Carbon steel stud type, sized as shown, complying with ASTM A 510, zinc plated in accordance with ASTM B633. See Drawings for additional information.
a. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
1) "Kwik Bolt 3" by Hilti
2) "Power Stud" by Powers Fasteners
3) "Red-Head Trubolt" by ITW Red-Head
4) "Wedge-All" by Simpson Strong-Tie

3. Screw Anchor for Anchorage Concrete, Solid Masonry or Grouted Masonry: Single-piece, fully-removable, zinc-plated carbon steel anchor with a hex-washer head. See Drawings for additional information.
a. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
1) "Kwik HUS-EZ" by Hilti
2) "Wedge-Bolt+" by Powers Fasteners
3) "Large Diameter Tapcon (LDT)" by ITW Red-Head
4) "Titen HD" by Simpson Strong-Tie

4. Adhesive Anchor for Anchorage to Hollow Masonry: Two-component adhesive anchor system for anchorage utilizing zinc-plated carbon steel threaded rod and screen tubes. See Drawings for additional information.
a. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
1) "HIT-HY 70 System" by Hilti
2) "AC100 + Gold System" by Powers Fasteners
3) "Epcon A7 System" by ITW Red-Head

D. Threaded Rods: ASTM A 36.
1. Nuts: ASTM A 563, Grade C, heavy-hex carbon steel.
2. Washers: ASTM F 436, Type 1, hardened carbon steel.
3. Finish: Plain Hot-dip zinc coating, ASTM A 153, Class C.

2.3 PRIMER AND COATINGS

A. Shop Primer for Interior Structural Steel: High solids, rust-inhibitive alkyd primer intended for protection for a short period of exposure in ordinary atmospheric conditions.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. "Series V10" by Tnemec
b. "6100 System Shop Coat Primer" by Rust-Oleum
c. "Kem Bond HS Universal Metal Primer" by Sherwin Williams

B. High Performance Paint System for Exterior Exposed Structural Steel:
1. Shop Coat: Tnemec 90-97 Primer
2. Intermediate (Field) Coat: Tnemec V69 Hi-Build Epoxoline II

3. Finish (Field) Coat: Tnemec 1075 Endura-Shield II

C. Field Primer for Marginally-Prepared Existing Rusty Steel: Single component, moisture-cured resin, containing a blend of micaceous iron oxide and zinc.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tnemec 90-97 Primer
      b. "MC-Miozinc 100" by Wasser
      c. "Corothane I Mio-Aluminum" by Sherwin Williams

2.4 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.
   1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
      a. "Masterflow 928" by BASF Building Systems
      b. "SikaGrout 328" by Sika
      c. "High Strength Grout" by Five-Star Products

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303 and 360.
   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.

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

D. Beam Copes: All re-entrant corners shall be shaped, notch free, to a radius of 1/2" minimum.

E. Connections: Weld or bolt shop connections using high-strength bolts in standard framed connections.

F. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

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

H. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning" or SP 3, "Power Tool Cleaning."

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Weld threaded nuts to framing and other specialty items indicated to receive other work.
   3.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified. Joint Type: Snug tightened, unless otherwise indicated on Drawings.

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

2.7 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.
   2. Surfaces to be field welded.
   3. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).

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” or SP 3 "Power Tool Cleaning."

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

2.8 SOURCE QUALITY CONTROL

A. Correct deficiencies in Work that Section 01 45 33 “Special Inspection and Testing” reports indicate do not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of -bearing surfaces and locations of, bearing plates, and other embedments for compliance with requirements.

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 ERECTION

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

B. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.

C. Maintain erection tolerances of structural steel within AISC 303.

D. 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 will be 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.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection.

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

H. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened, unless otherwise indicated on Drawings.

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.
   2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
   3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

C. Post-Installed Anchors: Install approved anchors in strict accordance with Drawings and anchor manufacturer's installation instructions.

3.5 FIELD PRIMING OF EXISTING RUSTED STEEL

A. Extent of rusted steel to receive coating to be determined in field.

B. Prepare steel surfaces per SSPC SP 2 "Hand Tool Cleaning" or SP 3 "Power Tool Cleaning". All steel surfaces to be clean and dry immediately prior to painting.

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. First Coat: Fully coat all steel surfaces to provide 2.5 - 3.5 mils dry film thickness.
   2. Second Coat: Fully coat all steel surfaces to provide 2.5 - 3.5 mils dry film thickness.

3.6 FIELD QUALITY CONTROL

A. Correct deficiencies in Work that Section 01 45 33 "Special Inspection and Testing" reports and inspections indicate do not comply with the Contract Documents. Costs for correcting Work and any retesting that may be necessary shall be at the Contractor's expense.

3.7 REPAIRS AND PROTECTION

A. Touchup Painting for Shop-Primed Steel: 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.

B. Touchup Painting for Field-Painted Steel: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION

WOOD, PLASTICS AND COMPOSITES

DIVISION 06

SECTION 06 40 23

INTERIOR ARCHTECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Custom library shelving.
   2. Custom countertops.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications
   1. Proof of five years of experience in the manufacturing of wood casework and furnishings.
   2. Proof of five completed installations, equal in size and educational requirements, which are available for inspection.
   3. Have adequate physical plant and personnel for manufacturing projects of this type and size.

B. Installer Qualifications
   1. List of five installations of same type materials with contact information.

C. Coordination
   1. Materials and stains/finishes to be coordinated between custom and manufactured items so that consistent and uniform appearance is achieved across all wood items.

1.4 WARRANTY

A. Contractor shall guarantee to replace or repair at his own expense all materials found to be defective in materials or workmanship for one year from date of Substantial Completion.

1.5 SUBMITTALS

A. Submit product data under provisions of Section 01 33 00 “Submittal Procedures”.

B. Include component dimensions, configurations, elevations, construction details, joint details, and attachments.

C. Submit samples under provisions of Section 01 33 00 “Submittal Procedures”.

1.6 QUALITY ASSURANCE

A. Surface-burning characteristics: maximum 200/450 flame-spread/smoke-developed index when tested according to ASTM E84.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 01 60 00 "Product Requirements".

B. Store products under provisions of Section 01 60 00 "Product Requirements".

C. Do not deliver furniture to site until destination space is ready to receive it, all overhead mechanical and electrical work is done and building relative humidity is stable between 25% and 55%.

D. Coordinate size of access and route to place of installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General regarding wood finishes.
   1. Red Oak shall be the species for this project where wood finish materials are specified.
   2. Wood and plywood grains, hues and matching will vary according to species, seasonal harvesting, manufacturing process and geographic origin. Visible surfaces of installed products shall be in conformance with industry-accepted standards.
   3. Cabinet and millwork components shall all be vertical grain oriented.

B. Lumber:
   1. All lumber used shall be of selected northern grown Red Oak, sound and free from checks and harmful case hardening.
   2. Lumber for interior construction shall be unselected as to grain and color.
   3. Lumber shall be properly air-dried, scientifically kiln dried in manufacturer's own controlled kilns, and then tempered to optimum moisture content (6-8%) prior to fabrication.
   4. All lumber on exposed surfaces shall be of the highest grade hardwood selected for grain and color.

C. Plywood for wood veneered finished products
   1. Exposed and Semi exposed surfaces of Red Oak plywood faces shall be plain sliced, book matched and grade AA for exposed and grade 1 for semi exposed and shall meet the definition set forth on ANSI/HPVA HP-1-2004.

D. Plywood for other finishes:
   1. Hardwood plywood with crossbands and all plywood must meet or exceed the standards set forth by the APA for structural use panels.
   2. 3/4" thick plywood shall be 7 ply. 1" thick shall be 9 ply.
   3. Only US or Canadian hardwood plywood's to be used. No other import plywood's will be acceptable.

E. Particleboard
   1. Shall be minimum 45lb. density industrial grade with a nominal 45-47 pound per cubic foot density.
   2. Minimum grade M-2l.

F. Plastic Laminate
   1. Surfaces shall be a high-pressure laminate .050" thick meeting NEMA specifications for use on horizontal work surfaces.
   2. Plastic laminate shall be selected by Owner from available wood grains, leathers, or solid colors in the standard matte or suede finishes from Wilsonart, Formica, Nevamar or Pionite.

G. Edge Banding
   1. Wood
      a. Library shelving: 3mm solid oak wood and applied utilizing hot melt adhesive and radiused by automatic trimmers.
      b. Manufactured Casework Cabinet Shelving and Cabinet Bodies: 3/8" solid oak, stick applied, radiused by automatic trimmers and applied.
   2. PVC
      a. Countertops 3mm PVC shall be color through and be applied utilizing hot melt adhesive and radiused by automatic trimmers. Edging shall be available in a minimum 48 color coordinated options.

2.2 CONSTRUCTION

A. General: All shelving, and countertops must utilize the best woodworking and casework practices and construction. All glues shall be top quality adhesives used in strict accordance with the Manufacturer's recommendations. Exposed surfaces shall be entirely free of machine marks.

B. Shelving Specifications
   1. Bookcase/Shelving Specifications:
      a. Shelving shall be sectional type of depth and height to match existing. All exposed materials shall be Red Oak hardwoods or veneers.
      b. Each section shall be maximum 36" to centers of uprights unless noted otherwise on the Drawings.
      c. All end and intermediate panels are 1" hardwood plywood core with premium grade "A" oak veneer on both faces; exposed edges are banded with 3mm solid oak with edges and corners radiused 1/8". All panels permit shelf adjustment on 32mm increments. Intermediate panels are machined on both faces. Threaded 5/16-18 metal inserts are embedded into the top and the bottom of the starter panels to facilitate attachment of the cornice top and toe assembly. Intermediate panels are machined for through bolts. Uprights glued-up of strips of lumber or less than 1" finished thickness will not be accepted.
      d. Adjustable shelves shall be 1" thick oak premium grade "A" plywood banded on front edge with 1/8" thick solid oak with edges and corners radiused 1/8". They are bored in 4 locations on the underside to accept seismically rated shelf pins. Shelves will deflect no more than 3/16" with a load of 55 lbs. per square foot. Each section of high (84") shelving shall have one removable flat bottom shelf and five adjustable shelves. Each section of medium (60" & 48") shelving shall have one removable bottom shelf and four adjustable shelves. Each section of

low (42" or lower) shelving shall have one removable bottom shelf and two adjustable shelves. Double faced shelving will have the quantities of shelves specified above on each face of the shelving.

e. Fixed Shelving Toe Assembly is a 4" high box frame constructed of 3/4" thick hardwood plywood. The assembly is bolted to the end and intermediate panels using 5/16" - 18 machine bolts. The base shelf is 3/4" thick engineered wood with select oak veneer face and 3mm solid Red Oak front band. It is supported on all four edges by the toe assembly and attached with two screws.

f. Backs: Backs are 1/4" thick MDF with oak hardwood veneer. They are standard with all 21-Series bookcase units.

C. Countertops:

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) The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

b. Grade: Custom.

c. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGL.

1) Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with manufacturers finish designations noted on the architectural drawings. Or as noted above in this specification.

d. Edge Treatment:

1) PVC:

(a) Countertop edges and exposed edges of splashes: 3mm PVC edging available in a minimum of 48 colors and applied with hot melt adhesive. Edges to be machined radiused top and bottom and at any corners. Hand radiused edges will not be acceptable

(b) Bottom edges of all splashes: .020 PVC available in the same colors as 3mm PVC. No raw edges of splash to be in contact with countertop surface.

(c) All PVC edges to be applied with hot melt glue

e. Core Material:

1) M-2 Particleboard at tops without sinks and moisture resistant, MR grade, M-2 particleboard at any countertops containing sinks. Compliant with ANSI A208.1, Grade M-2-Exterior Glue.

2) Core Thickness: solid 1-1/8

f. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate

2.3 HARDWARE AND ACCESSORIES

A. Adjustable Shelf Supports:

1. Two-pin-locking plastic w/nylon added shelf rests/clips complying with ANSI/BHMA A156.9, Type B04013

2. Adjustable seismic shelf supports shall be double pin, plastic locking type, able to accommodate both ¾" and 1" thick shelves.

3. Shelf clips shall be tested and rated for 300 lb load per clip. Provide information in submittals attesting to this load rating. Clips with less load rating are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LIBRARY SHELVES

A. Install level, plumb, and true; With the exception of library shelving, shim as required, and using concealed shims. Where library shelving abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

B. Install hardware uniformly and precisely.

3.3 INSTALLATION OF COUNTERTOPS

A. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection.

B. Field Jointing: Where possible, make in same manner as shop-made joints using dowels, splines, fasteners, adhesives, and sealants recommended by Manufacturer. Prepare edges in shop for field-made joints.

C. Provide required holes and cutouts for grommets, grilles or other materials provided under other scopes of work or other contractors.

D. Provide silicone based sealant at junctures of countertop, curb, and splash with walls as recommended by Manufacturer for materials involved.

E. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 CLEANING AND PROTECTING

A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

B. Protect countertop and shelving surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

END OF SECTION

THERMAL AND MOISTURE PROTECTION

DIVISION 07

SECTION 07 53 23

ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING (SELF ADHERED)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Wood nailers
   2. Metal roof edging
   3. Walkway pads
   4. Flashing Sleeves
   5. Safety Guardrails
   6. Other roofing related items indicated on Drawings or otherwise necessary to provide a complete weatherproof roofing.

B. Related Requirements:
   1. Section 07 01 50 19 "Preparation for Reroofing".

1.3 REFERENCES

A. Referenced Standards: These standards form part of this Specification only to the extent they are referenced as Specification requirements.
   1. ASTM C1177 / C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2006.
   2. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2013.
   3. ASTM D4637 - Standard Specification for EPDM Sheet used in Single-Ply Roof Membrane; 2004.
   4. ASTM D4811 - Standard Specification for Nonvulcanized (Uncured) Rubber Sheet Used as Roof Flashing; 2004.
   5. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.
   6. FM 4470 - Approval Standard - Class I Roof Covers; current version.
   7. PS 1 - Construction and Industrial Plywood; 2009.
   8. PS 20 - American Softwood Lumber Standard; 2010.
   9. SPRI ES-1 - Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems; 2007. (ANSI/SPRI ES-1).

1.4 PERFORMANCE REQUIREMENTS

A. Conform to applicable code for roof assembly fire hazard requirements.

B. UL 790: Class A Fire Hazard Classification.

C. FM 4470: Roof Assembly Classification, of Class 1 Construction, wind uplift requirement, in accordance with FM Construction Bulletin 1-28.

D. Roof Assembly to resist wind speed of 90 MPH, Class 75.

1.5 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.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NRCA Roofing and Waterproofing Manual and FM Global Requirements.

B. The Manufacturer must have a minimum of 25 years' experience in the manufacturing of vulcanized thermal set sheeting, and be the primary Roof Membrane Manufacturer.

C. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
   1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
   2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

D. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by Roofing Manufacturer based on testing and field experience.

E. Unless otherwise noted in this specification, the roofing contractor must strictly comply with the Manufacturer's current specifications and details.

F. The roofing system must be installed by an applicator authorized and trained by the Manufacturer in compliance with shop drawings as approved by the Manufacturer. The roofing applicator shall be thoroughly experienced and upon request be able to provide evidence of having at least twenty (20) years successful experience installing single-ply EPDM roofing systems and having installed at least ten (10) roofing applications of similar or equal scope.

G. Provide adequate number of experienced workmen regularly engaged in this type of work who are skilled in the application techniques of the materials specified. Provide at least one thoroughly trained and experienced, in roofing manufactured system, superintendent on the job at all times roofing work is in progress.

H. Upon completion of the installation, the applicator shall arrange for an inspection to be made by a non-sales technical representative of the Membrane Manufacturer in order to determine whether or not corrective work will be required before the warranty will be issued. Notify the Architect seventy-two (72) hours prior to the Manufacturer's final inspection.

1.7 ACTION SUBMITTALS

A. Product Data:
   1. Provide for:
      a. Accessory roofing materials.
   2. Provide Membrane Manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the Membrane Manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.
   3. Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.
   4. Installation Instructions: Provide Manufacturer's instructions to Installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:
   1. Base flashings and membrane terminations.
   2. Insulated roof curb dimensions for each location in relation to existing ceilings and units.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Manufacturer.

B. Manufacturer Certificates: Signed by Roofing Manufacturer certifying that roofing system complies with requirements specified.
   1. Submit evidence of complying with performance requirements.

C. Product Test Reports: For components of roofing system, tests performed by Manufacturer and witnessed by a qualified testing agency.

D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field quality-control reports.

F. Sample Warranties: For Manufacturer's special warranties.

1.9 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with Manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by Roofing System Manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with Insulation Manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.11 JOB CONDITIONS

A. Material Safety Data Sheets (MSDS) must be on location at all times during the transportation, storage and application of materials.

B. Provide a minimum of 3 pull out tests of each roof area before starting the project and submit results to Architect.

C. When positioning membrane sheets, exercise care to locate all field splices away from low spots. All field splices should be shingled to prevent bucking of water.

D. When loading materials onto the roof, the Roofing Installer must comply with the requirements of the Building Owner to prevent overloading and possible disturbance to the building structure.

E. Proceed with roofing work only when weather conditions are in compliance with the Manufacturer's recommended limitations, and when conditions will permit the work to proceed in accordance with the Manufacturer's requirements and recommendations.

F. Proceed with work so new roofing materials are not subject to construction traffic. When necessary, new roof sections shall be protected and inspected upon completion for possible damage.

G. Provide protection, such as 1/2-inch thick plywood, for all roof areas exposed to traffic during construction. Plywood must be smooth and free of fasteners and splinters.

H. New roofing work shall be complete and weathertight at the end of the workday.

I. Contaminants such as grease, fats and oils shall not be allowed to come in direct contact with the roofing membrane.

1.12 WARRANTY

A. Warranty: Use Manufacturer approved roofing contractor to maintain existing roofing system warranty.

B. Special Project Warranty: Submit roofing Installer's warranty, on their company letterhead, signed by Installer, covering Work of this Section, including all work, for the following warranty period:
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer - Roofing System: Firestone Building Products Co.

B. Provide a Class A roof covering and assembly.

2.2 EPDM MEMBRANE MATERIALS

A. Roofing and Flashing Membrane: Black cured synthetic single-ply membrane composed of ethylene propylene diene terpolymer (EPDM) with the following properties:
   1. EPDM Sheet: ASTM D4637/D4637M, self-adhering.
   2. Thickness: 0.060 inch.
   3. Nominal Thickness Tolerance: Plus/minus 10 percent.
   4. Sheet Width: Provide the widest available sheets to minimize field seaming.

B. Fasteners: Type and size as required by Roof Membrane Manufacturer for roofing system and warranty to be provided; use only fasteners furnished by Roof Membrane Manufacturer.

C. Use accessories and flashings of like color to the primarily specified field EPDM membrane.

D. Flashing Membrane: Self-curing, non-reinforced membrane composed of nonvulcanized EPDM rubber, complying with ASTM D 4811 Type II, and with the following properties:

1. Thickness: 0.060 inch.

E. Self-Adhesive Flashing Membrane: Semi-cured 45 mil EPDM membrane laminated to 35 mil EPDM tape adhesive; QuickSeam Flashing.

F. Pre-Molded Pipe Flashings: EPDM, molded for quick adaptation to different sized pipes; Firestone EPDM Pipe Flashing.

G. Self-Adhesive Lap Splice Tape: 35 mil EPDM-based, formulated for compatibility with EPDM membrane and high-solids primer.

H. Splice Adhesive: Synthetic polymer-based, formulated for compatibility with EPDM membrane and metal surfaces.

I. Bonding Adhesive: Acrylic-based, water-borne, formulated for compatibility with EPDM membrane and wide variety of substrate materials, including masonry, wood, and insulation facings.

J. Seam Edge Treatment: EPDM rubber-based sealant, formulated for sealing exposed edges of membrane at seams.

K. Pourable Sealer: Two-part polyurethane, two-color for reliable mixing.

L. Water Block Seal: Butyl rubber sealant for use between two surfaces, not exposed.

M. Metal Plates and Strips Used for Fastening Membrane and Insulation: Steel with Galvalume coating; corrosion-resistance meeting FM 4470 criteria.

N. Termination Bars: Aluminum bars with integral caulk ledge; 1.3 inches wide by 0.10 inch thick.

O. Roof Walkway Pads: EPDM, 0.30 inch thick by 30 by 30 inches with EPDM tape adhesive strips laminated to the bottom; QuickSeam Walkway Pads.

2.3 ACCESSORY MATERIALS

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Width: 3-1/2 inches, nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.
   2. Thickness: Same as thickness of roof insulation, or as shown on Drawings.

2.4 PREFORMED FLASHING SLEEVES

A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted or perforated metal collar.
   1. Metal: Aluminum sheet, 0.063 inch thick.
   2. Diameter: As indicated on Drawings.

3. Finish: Manufacturer's standard.

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
1. Metal: Aluminum sheet, 0.063 inch thick.
2. Height: 13 inches.
3. Diameter: Field verify each location.
4. Finish: Manufacturer's standard.

2.5 SAFETY GUARDRAIL

A. Manufacturer: Safety Rail Source, NEXTGEN 3000™ UNIVERSAL GUARDRAIL Basis of Design.

B. The safety guardrail system shall be field assembled and installed as per the manufacturer's instructions.

C. Performance Characteristics:
1. High visibility safety yellow color shall be molded in.
2. Safety guardrail system shall satisfy the requirements of OSHA 29 CFR 1910.28 and shall meet OSHA strength requirements.
3. UV and corrosion resistant construction with a 20-year warranty.
4. Posts and Rails: Shall be constructed of galvanized steel.
5. Guardrail height: 42 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section "Steel Decking."
4. Verify that minimum concrete drying period recommended by Roofing System Manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
8. Verify adjacent cementitious wood-fiber panels are vertically aligned to within 1/8 inch (3.2 mm) at top surface.

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

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to Roofing System Manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Install sound-absorbing insulation strips according to acoustical Roof Deck Manufacturer's written instructions.

3.3 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by Membrane Manufacturer's recommendations and details.

B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the Drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.
   1. Follow Roofing Manufacturer's instructions.
   2. Remove protective plastic surface film immediately before installation.
   3. Install water block sealant under the membrane anchorage leg.
   4. Flash with Manufacturer's recommended flashing sheet unless otherwise indicated.
   5. Where single application of flashing will not completely cover the metal flange, install additional piece of flashing to cover the metal edge.
   6. If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, install an additional piece of self-adhesive flashing membrane over the metal lap to the top of the gravel stop; apply seam edge treatment at the intersections of the two flashing sections.
   7. When the roof slope is greater than 1:12, apply seam edge treatment along the back edge of the flashing.

C. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weathertight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing membrane abuts to; extend flashing at least 8 inches (200 mm) high above membrane surface.
   1. Use the longest practical flashing pieces.
   2. Evaluate the substrate and overlay and adjust installation procedure in accordance with Membrane Manufacturer's recommendations.
   3. Complete the splice between flashing and the main roof sheet with specified splice adhesive before adhering flashing to the vertical surface.
   4. Provide termination directly to the vertical substrate as shown on Roof Drawings.

D. Flashing at Penetrations: Flash all penetrations passing through the membrane; make flashing seals directly to the penetration.

1. Pipes, Round Supports, and Similar Items: Flash with specified pre-molded pipe flashings wherever practical; otherwise use specified self-curing elastomeric flashing.
2. Pipe Clusters and Unusual Shaped Penetrations: Provide penetration pocket at least 2 inches deep, with at least 1 inch clearance from penetration, sloped to shed water.
3. Structural Steel Tubing: If corner radii are greater than 1/4 inch and longest side of tube does not exceed 12 inches, flash as for pipes; otherwise, provide a standard curb with flashing.
4. Flexible and Moving Penetrations: Provide weathertight gooseneck set in sealant and secured to deck, flashed as recommended by Manufacturer.

3.4 INSULATED ROOF CURB INSTALLATION

A. Install as per manufacturer's instructions. Clear height shall be 10" above roof membrane. Modify ductwork to accept new curb height. Field verify during bidding and once the units are taken down.

3.5 WALKWAY INSTALLATION

A. Install walkways around new rooftop equipment that may require maintenance, and where indicated on the Drawings.
   1. Use specified walkway pads.

B. Walkway Pads: Adhere to the roofing membrane, spacing each pad at minimum of 1.0 inch and maximum of 3.0 inches from each other to allow for drainage.
   1. If installation of walkway pads over field fabricated splices or within 6 inches of a splice edge cannot be avoided, adhere another layer of flashing over the splice and extending beyond the walkway pad a minimum of 6 inches on either side.
   2. Prime the membrane, remove the release paper on the pad, press in place, and walk on pad to ensure proper adhesion.

3.6 FIELD QUALITY CONTROL

A. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   1. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
   2. Flood each area for 24 hours.
   3. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

B. Final Roof Inspection: Arrange for Roofing System Manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.7 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

SECTION 07 84 13

JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated construction.
   2. Construction-gap firestopping at connections of same or different materials in fire-rated construction.
   3. Construction-gap firestopping occurring within fire-rated wall.
   4. Construction-gap firestopping occurring at the top of fire-rated walls.
   5. Construction-gap firestopping occurring at the top of non-fire-rated walls.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

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".

2.2 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.
   1. Acceptable Manufacturers and Products: Those listed in the UL Fire Resistance directory for the UL System involved.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   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 E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   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.

D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
   1. Permanent forming/damming/backing materials.
   2. Substrate primers.
   3. Collars.
   4. Steel sleeves.

2.3 FILL MATERIALS

A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

C. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

D. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

E. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

F. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

G. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

I. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. 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.

3.4 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 high and with minimum 0.375-inch strokes.
1. Locate in accessible concealed ceiling space at 15 feet from end of wall and at intervals not exceeding 30 feet.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections according to ASTM E2174.

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.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods

and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Penetration Firestopping Systems with No Penetrating Items:
   1. UL-Classified Systems: W-L-0001-0999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

C. Penetration Firestopping Systems for Metallic Pipes, Steel, Sheet Metal, Conduit, or Tubing:
   1. UL-Classified Systems: W-L-1001-1999, or Engineering Judgement.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

D. Penetration Firestopping Systems for Nonmetallic Pipe, Conduit, or Tubing:
   1. UL-Classified Systems: W-L-2001-2999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

E. Penetration Firestopping Systems for Electrical Cables:
   1. UL-Classified Systems: W-L-3001-3999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

F. Penetration Firestopping Systems for Cable Trays with Electric Cables:
   1. UL-Classified Systems: W-L-4001-4999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

G. Penetration Firestopping Systems for Insulated Pipes:
   1. UL-Classified Systems: WL-5001-5999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

H. Penetration Firestopping Systems for Miscellaneous Electrical Penetrants:
   1. UL-Classified Systems: WL-6001-6999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

I. Penetration Firestopping Systems for Miscellaneous Mechanical Penetrants:
   1. UL-Classified Systems: WL-7001-7999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

J. Penetration Firestopping Systems for Groupings of Penetrants:
   1. UL-Classified Systems: WL-8001-8999.
   2. F-Rating: 1-hour
   3. T-Rating: 1-hour
   4. Type of Fill Materials: As required to achieve rating.

K. Firestopping for Steel Beam:
   1. Hilti: Fire Finish 120+ CFP-SP WB or All-Weather High Build CFP-SP AW HB.

L. Firestopping at Metal Deck Flutes and Gaps between Bar Joints.
   1. Fill gaps with mineral wool. Apply minimum 1/8" (wet) thickness Hilti CFS-SP WB Firestop Joint Spray to completely cover mineral wool. Overlap spray 1-inch on all sides.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes sealants and joint backing**,** precompressed foam sealers, and accessories.

1.2 REFERENCES

A. ASTM International:
   1. ASTM C834 - Standard Specification for Latex Sealants.
   2. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
   3. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
   4. ASTM C1193 - Standard Guide for Use of Joint Sealants.
   5. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
   6. ASTM D1667 - Standard Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
   7. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Products Data: Submit data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

C. Samples: Submit two samples, 6 x 6 inch in size illustrating sealant colors for selection.

D. Manufacturer's Installation Instructions: Submit special procedures, surface preparation, and perimeter conditions requiring special attention.

E. Warranty: Include coverage for installed sealants and accessories failing to achieve airtight seal, or watertight seal, exhibit loss of adhesion or cohesion, and sealants which do not cure.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience, and approved by Manufacturer.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Maintain temperature and humidity recommended by Sealant Manufacturer during and after installation.

1.6 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate Work with Sections referencing this Section.

PART 2 - PRODUCTS

2.1 JOINT SEALERS

A. Manufacturers:
1. BASF/Sonneborn.
2. SIKA Corporation.
3. Dow Corning Corporation.
4. GE Construction Sealants.
5. Pecora Corporation.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Products Description:
1. High Performance General Purpose Exterior (Nontraffic) Sealant (Sealant Type A): Polyurethane; Grade NS, Class 25, Uses M, G, and A; multi-component.
   a. Type: NP 2 manufactured by BASF/Sonneborn.
   b. Color: As selected from standard and optional colors line.
   c. Applications: Use for:
      1. Control, expansion, and soft joints in masonry.
      2. Joints between concrete and other materials.
      3. Joints between metal frames and other materials.
      4. Other exterior nontraffic joints for which no other sealant is indicated.
      5. Under thresholds.
2. General Purpose Interior Sealant polyurethane; ASTM C920, single component, paintable.
   a. Type: NPI manufactured by BASF/Sonneborn.
   b. Color: Color as selected.
   c. Applications: Use for interior wall and ceiling control joints, joints between door and window frames and wall surfaces, and other interior joints for which no other type of sealant is indicated:
3. Sanitary Joints: Silicone; ASTM C920, Type S, Grade NS, Class 25, single component, mildew resistant.
   a. Color: Color as selected.

b. Applications: Use for joints between plumbing fixtures and floor and wall surfaces, and joints between kitchen and toilet room countertops and wall surfaces and pipe penetrations.

4. Interior Caulk: ASTM C834, acrylic latex, Type OP,
   a. Applications: Use for exposed and concealed acoustical joints.
      1. Provide sealant bead between top stud runner and structure and between bottom stud track and floor.
   b. Narrow interior joints.
5. General Purpose Traffic Bearing Sealant: Elastomeric Polyurethane; ASTM C920, Grade P types, Class 25, Use T, single component, self-leveling.
   a. Type: SL 1 manufactured by BASF/Sonneborn.
   b. Color: Color as selected.
   c. Applications: Use for:
      1. Exterior pedestrian sidewalk and vehicular traffic bearing joints.
      2. Expansion joints at tiles.

2.2 ACCESSORIES

A. Primer: Non-staining type, recommended by Sealant Manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by Sealant Manufacturer; compatible with joint forming materials.

C. Joint Backing:
   1. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealant, primers, and other joint fillers; and are approved for applications indicated by Sealant Manufacturer based on field experience and laboratory testing.
   2. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
      a. Type C: Closed-cell material with a surface skin.
   3. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26° F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

D. Bond Breaker Tape: polyethylene tape or other plastic tape recommended by Sealant Manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

E. Filler:
   1. Mineral Fiber Board: ASTM C612, Class 1.
   2. Thickness same as joint width.
   3. Depth to fill void completely behind back-up rod.

PART 3 - EXECUTION

3.1 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean adjacent soiled surfaces.

3.2 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Protect sealants until cured.

END OF SECTION

FINISHES

DIVISION 09

SECTION 09 91 23

INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following substrates:
   1. Concrete Masonry Units (CMUs).
   2. Steel and iron.
   3. Galvanized metal.
   4. Gypsum board.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.
   1. Submit Samples on rigid backing, 8 inches square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.

4. Label each Sample for location and application area.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg. F.
1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg. F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg. F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Sherwin Williams and Tnemec or comparable product by one of the following:
1. Benjamin Moore & Co.
2. Behr Process Corporation.
3. PPG Architectural Finishes, Inc.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:
1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: As selected by Architect from manufacturer's full range.
1. Three types of color will be selected for types of surface painted.

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 the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   2. Masonry (Clay and CMUs): 12 percent.
   3. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer, but not less than the following:
   1. SSPC-SP 2.
   2. SSPC-SP 3.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
   5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. 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.

D. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed in rooms:
      a. Equipment, including panelboards and switch gear.
      b. Uninsulated metal piping.
      c. Uninsulated plastic piping.
      d. Pipe hangers and supports.
      e. Metal conduit.
      f. Plastic conduit.
      g. Tanks that do not have factory-applied final finishes.
      h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   2. Paint the following work where exposed in occupied spaces:
      a. Equipment, including panelboards.
      b. Uninsulated metal piping.
      c. Uninsulated plastic piping.
      d. Pipe hangers and supports.
      e. Metal conduit.
      f. Plastic conduit.
      g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      h. Other items as directed by Architect.
   3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
   1. Contractor shall touch up and restore painted surfaces damaged by testing.
   2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. 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.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Masonry - CMU (All areas, except as indicated.
   1. Semi-Gloss Finish (All areas, except as indicated).
      a. Primer Coat: S-W PrepRite Block Filler, B25W25.
      b. First Coat: S-W Promar 200 Zero VOC Latex Semi-Gloss B31-2600 Series.
      c. Second Coat: S-W Promar 200 Zero VOC Latex Semi-Gloss B31-2600 Series.
   2. High Performance Finish (Toilets and Locker Rooms)
      a. Primer Coat: Loxon Block Surfacer, A24W200.
      b. First Coat: Pro Industrial Water-Based Catalyzed Epoxy Gloss, B73-300 Series.
      c. Second Coat: Pro Industrial Water-Based Catalyzed Epoxy Gloss, B73-300 Series.

B. Gypsum Board Walls.
   1. Semi-Gloss Finish
      a. Primer Coat: Promar 200 Zero VOC Latex Primer, B28W2600.
      b. First Coat: Promar 200 Zero VOC Latex Semi-Gloss B31-2600 Series.
      c. Second Coat: Promar 200 Zero VOC Latex Semi-Gloss B31-2600 Series.

C. Ferrous Metal.
   1. Semi-Gloss Finish (Doors, Frames and Miscellaneous Metals).
      a. Primer Coat: Pro Industrial ProCryl Universal Primer, B66-310 Series.
      b. First Coat: Pro Industrial Acrylic Semi-Gloss, B66-650 Series.
      c. Second Coat: Pro Industrial Acrylic Semi-Gloss, B66-650 Series.

END OF SECTION

FURNISHINGS

DIVISION 12

SECTION 12 32 16

MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad casework.
   2. Hardware and accessories.

1.2 DEFINITIONS

A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.5 ACTION SUBMITTALS

A. Product Data:
   1. Plastic-laminate-clad casework.
   2. Hardware and accessories.

B. Shop Drawings: For plastic-laminate-clad casework.
   1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
   2. Indicate types and sizes of casework.
   3. Indicate manufacturer's catalog numbers for casework.
   4. Show fabrication details, including types and locations of hardware.
   5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.

C. Samples for Initial Selection: For casework and hardware finishes.

D. Samples for Verification: For the following:
   1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
      a. Provide one Sample applied to core material with specified edge material applied to one edge.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For casework manufacturer and Installer.

B. Sample Warranty: For special warranty.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: [An authorized representative who is trained and approved by manufacturer] [and] [Licensed participate in AWI's Quality Certification Program] [Licensed participate in WI's Certified Compliance Program].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during remainder of construction period. Maintain temperature and relative humidity during remainder of construction period in range recommended for Project location by the AWI/AWMAC/WI's "Architectural Woodwork Standards."

B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Delamination of components or other failures of glue bond.
      b. Warping of components.
      c. Failure of operating hardware.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
   1. Grade: Custom.

B. Product Designations:
   1. Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 01 60 00 "Product Requirements."
   2. Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.2 PLASTIC-LAMINATE-CLAD CASEWORK

A. Source Limitations: Obtain from single source from single manufacturer.

B. Design: Frameless cabinet construction.

C. Grain Direction for Wood-Grain Plastic Laminate:
   1. Face Frame Members: Lengthwise.
   2. End Panels: Vertical.
   3. Bottoms and Tops of Units: Side to side.
   4. Knee Space Panels: Vertical.
   5. Aprons: Horizontal.

D. Exposed Materials:
   1. Plastic-Laminate Grade: HGS.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
   2. Edgebanding: PVC.
      a. PVC Edgebanding Color: As selected by Architect from casework manufacturer's full range.

E. Semiexposed Materials:
   1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
      b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
   2. Thermally Fused Laminate (TFL) Panels: Provide thermally fused laminate panels for semiexposed surfaces unless otherwise indicated.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.

b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.

3. Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.

F. Concealed Materials:
1. Solid Wood: With no defects affecting strength or utility.
2. Plywood: Hardwood plywood.
3. Plastic Laminate: Grade VGS.
4. Particleboard.
5. MDF.

2.3 HARDWARE AND ACCESSORIES

A. Hardware: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

B. Grilles: Grille with frame, power coat aluminum construction.
1. Frame: Mitered corners and beveled edges.
2. Colors: As selected by Architect from manufacturer's full range.

2.4 MATERIALS

A. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

B. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

C. Softwood Plywood: DOC PS 1.

D. Particleboard: ANSI A208.1, Grade M-2.

E. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.

F. Hardboard: ANSI A135.4, Class 1 tempered.

G. Plastic Laminate: High-pressure decorative laminate complying with ISO 4586-3.
1. Source Limitations: Obtain from single source from single manufacturer.

H. PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

I. Thermally Fused Laminate Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paperand complying with requirements of ISO 4586.
1. Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC edgebanding matching thermally fused laminate panels.

2.5 FABRICATION

A. Plastic-Laminate-Clad Cabinet Construction: As required by referenced quality standard, but not less than the following:
   1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch-thick plywood or 1-inch-thick particleboard.
   2. Shelves: 3/4-inch-thick plywood or 1-inch-thick particleboard.
   3. Backs of Casework: 1/2-inch-thick particleboard or MDF where exposed, dadoed into sides, bottoms, and tops where not exposed.

B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Grade: Install casework to comply with same quality standard grade as item to be installed.

B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.

D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.

E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."

F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION

HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

DIVISION 23

SECTION 23 00 05

MECHANICAL WORK GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 ALLOWANCES, ALTERNATES AND UNIT PRICES

A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.3 INTENT

A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.4 DEFINITIONS

A. Provide: Furnish, install and connect.
B. Furnish: Supply material only.
C. EXR: Existing to remain.
D. MC: Mechanical Contractor-note MC and HC (Heating Contractor) shall be interchangeable for all drawings and specifications.

1.5 SCOPE OF WORK

A. This Contractor shall do all work, furnish all labor, tools and equipment necessary for all the MECHANICAL work all as indicated on the drawings and specified herein.
   1. Removal of existing equipment as indicated on drawings.
   2. All cutting and patching.
   3. Roof top units, complete with curbs, etc. Flashing by G.C.
   4. Variable refrigerant system, complete with all accessories.
   5. Central station air handling units.
   6. Air cooled condenser units;
   7. Unit ventilators.
   8. Ductless split air conditioning units, complete with piping, controls, supports and accessories.
   9. Fin tube radiation, complete with piping and accessories.
   10. Unit heaters, complete with piping, supports and accessories.
   11. Duct coils, complete with piping and installation accessories.
   12. Circulating pumps complete with motors, controls, supports and accessories.

13. Exhaust fans, complete with accessories, curbs, etc., flashing by GC.
14. Drain water condensate pump, complete with piping, tank, accessories and support.
15. Pipe fittings, hangers, supports, valves, and piping specialties as required to make complete heating system.
16. Refrigeration piping, fittings, valves, etc.
17. All diffusers, registers and grilles complete with accessories.
18. All louvers provided by Contractor.
19. Galvanized ductwork (or specialty ductwork where noted) to serve supply, relief and exhaust systems complete with control devices and accessories, unless otherwise noted.
20. Insulation both thermal and acoustical to serve piping, ductwork systems, equipment, housings and accessories.
21. Temperature control system complete to serve all MECHANICAL equipment and systems complete with accessories.
22. Testing and balancing of all heating, ventilating and air conditioning installations to include sheetmetal ductwork, air conditioning supply and exhaust systems, heating and cooling systems and temperature control system. Balancing shall include NC ratings as described herein.
23. Special testing and balancing requirements for existing MECHANICAL equipment to include repair of existing equipment as required to obtain air flow as indicated on drawings.
24. Servicing of heating, ventilating and air conditioning facilities are required for guarantee period. Provide competent factory trained men at site for purpose of instructing Owner's personnel in proper operation and maintenance of all new MECHANICAL facilities.
25. Concrete pads, 4" high unless otherwise noted on drawings, to provide housekeeping elevation for boilers, pumps and such other equipment as shown on drawings that require a pad. Coordinate installation of pads with GC to insure secure bonding of pads to floor structure. This contractor shall be responsible for installation of pads.
26. Temporary heat as required by Architect's Special Conditions.

1.6 TEMPORARY SERVICES

A. Temporary Heat: In accordance with Architect's specifications and/or conditions, contractor shall have the permanent heating system capable of providing heat to the new work areas when required. The term heating system shall include all work or components necessary to operate heating system. For temporary usage, it is not required that this work be in a finished condition, i.e., covers in place, etc. Cost of fuel consumed for temporary heat from permanent systems only shall be paid by owner.

B. The use of permanent system will be allowed only if the building is fully enclosed with no construction dust to clog heating/cooling coils, heat recovery components, fans, etc.

C. At the completion of work, Contractor shall turn over to the Owner all equipment used for temporary heat in a new, as purchased condition. Contractor shall replace filters with new ones, clean all components which shall include: unit casings, ductwork, grilles, diffusers, etc., re-lubricate all moving parts, replace belts if required and perform any other work necessary (as determined by Architect and Engineer) to put equipment

in a "new" condition.

D. Contractor shall take all measures necessary to insure that dust, dirt, or debris does not enter air systems while in operation for temporary heat and shall change filters as often as necessary. Under no circumstances shall air handlers be allowed to operate with no filter in place. All duct in the work area shall be sealed so no dust or debris will enter duct.

1.7 CONTINUITY OF UTILITY SERVICES

A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.8 CODES AND STANDARDS

A. All materials, equipment, and installations by this contract shall be in accordance with the latest editions of the following applicable requirements:
   1. 2020 New York State Building Code, including all applicable amendments supplements to the following:
      a) 2018 International Building Code
      b) 2018 International Existing Building Code
      c) 2018 International Fire Code
      d) 2018 International Plumbing Code
      e) 2018 International Mechanical Code
      f) 2018 International Fuel Gas Code
   2. 2020 Supplement to the New York State Energy Conservation Construction Code, including all applicable amendments to the following:
      a) 2018 International Energy Conservation Code
      b) 2013 ASHRAE 90.1
   3. 2020 Uniform Code Supplement (May 12, 2020)
   4. New York State Department of Environmental Conservation.
   5. Conform to requirements of NEMA.
   6. Bear label of Underwriters Laboratories, Inc.
   7. National Electrical Code NFPA Article 70, latest edition.
   8. New York State Health Code.
   9. Local Utility Standards.
   10. Local Municipal and/or city standards.
   11. Industrial Code Rule #4 and #14 (12NYCRR 4 and 14) (Standards for boiler installation).
   12. AMBA Boiler Rating.
   13. ASME Boiler Pressure Vessel Code.
   14. ASHRAE Standard 15.
   15. Conform with applicable requirements of ASTM - Regulations and Standards for Pipe and Pipe Fittings.
   16. Be in accordance with USAS - Code for Pressure Piping, latest edition.

17. For external and internal duct insulations, have flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM Standard E84.
18. Sheetmetal and Air Conditioning Contractor's National Association, Inc. (SMACNA), latest editions.
19. Conform with applicable requirements of Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A, and Code for Safety to Life from Fire in Buildings and Structures, NFPA 101.
20. Conform to requirements of ASHRAE 90.1, latest edition.
21. Be in accordance with design standards outlined in ASHRAE Handbooks, latest edition.
22. Conform to requirements of Owner's insurance carriers.

1.9 SUBMITTALS & SUBMISSION REQUIREMENTS

A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.
   1. Within (20) days after receiving notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed.
   2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.
   3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page (s) shall also indicate project name and building name.
   4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usages, model numbers, construction materials, performance, data, etc.
   5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)
   6. The contractor shall insure that dimensions of equipment to be used conform to the space allocated for the equipment on the drawings.
   7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.
   8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.

B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.

C. Substitutions (where allowed within the project):
   1. After bid award if there are any units/piping/equipment the contractor would seek to substitute on, they must indicate in writing the specific equipment.
   2. All substitutions shall be clearly highlighted, and in bold print, on the front cover of any submittal that it is a substitution.
   3. Substitutions received after 45 days will not be considered.
   4. Supporting documentation shall be provided describing why the item is an equal and listing the major difference.
   5. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.
   6. Any substitution should be sent in as an RFI and reviewed prior to bid for acceptance. If the unit is submitted after the bid date, the submittal may be rejected without review.
   7. Approval of substitute equipment shall be based on performance, dimensional, functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer. Any substitution shall meet any scheduled performance and characteristics noted within its particular specification section.
   8. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable, including but not limited to any design fees and structural or steel changes required to implement a substituted unit.
   9. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.
   10. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.10 SUBSTANTIAL COMPLETION REQUEST FOR PUNCH LIST

A. Contractor shall submit a letter in email form stating that the work is substantially complete and ready for Punch List review by Engineer.

B. Contractor shall note which areas are substantially complete by Building (if multiple buildings) and by Area according to the Key Plan.

C. Contractor shall list all items that are known to be incomplete at time of submission.

D. If the request is for a partial Punch List, Contractor shall also include a list of room numbers/room tags.

E. When letter is received by the Engineer, site review(s) will be coordinated with the Construction Manager, Clerk, Architect.

1.11 CUTTING AND PATCHING

A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.

B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.

C. Should changes, omissions or errors in this contractor's work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at contractor's expense.

D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.

E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.

F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.

G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc.

H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

I. If the MC has a duct or pipe going through a wall where the GC made an opening for the MC, the MC shall be responsible to infill the space between the duct/pipe and wall. Also refer to section 1.22 Penetrations through fire rated construction.

1.12 FIELD INSPECTION

A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.13 INSTRUCTION SERVICES AND MANUALS

A. Instructions:
   1. Provide competent personnel to remain at the jobsite for necessary time to instruct the Owner's personnel in proper operation and maintenance of installation made by this contractor.
   2. This contractor shall be responsible for notifying and instructing Owner's personnel on all equipment operations, maintenance requirements, etc. Furnish operating training session(s) for equipment listed.
   3. The Owner shall be responsible for establishing an operating and maintenance program for all equipment listed.

B. Training Session: A training session shall be held for each system and/or item listed below: (Note: For Temperature Controls refer to Temperature Control Sections for training requirements.)

Item	Description	Training Hours For Each Bldg
1.	Air Handling Unit(s)	2
2.	VRF Condensing Unit(s)	3
3.	Air Cooled Condensing Unit(s)	2
4.	Split System(s)	2
5.	Pump(s)	2
6.	Rooftop Unit(s)	4
7.	Unit Ventilator(s)	3
8.	PTAC(s)	2

C. The instruction shall include the following types of information:
   1. System overview
   2. Major component designation
   3. System operation procedures
   4. Maintenance scheduling and procedures
   5. Provide a list of spare components each system would normally require

D. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.

E. Manuals: Submit (3) sets of Operation and Maintenance manuals. Each set shall contain the manufacturers' data, operating instruction parts catalog and maintenance procedures for each piece of equipment. Include normal maintenance servicing schedule to be performed by the Owner.
   1. For projects containing multiple buildings, manuals shall be submitted separately for each building.

1.14 PERMITS, CERTIFICATES AND FEES

A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below and as required. Costs for permits, fees etc. shall be included in the base bid amount.
   1. All required applications and permits to begin work
   2. Certificate of inspection including Third-Party Agency.
   3. All municipal connection charges

4. All local utility charges (power, telephone, cable, etc.)
5. Fees and charges shall be obtained directly from the respective authority having jurisdiction
6. Fees and charges for hazardous waste hauling as required by DOT, DEC, etc.

1.15 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

A. All removed equipment shall be removed from the site and properly disposed of.

B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies. The contractor shall provide the owner with written chain of custody reports and final destination of disposal.

C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

D. Unless otherwise noted, all equipment to be removed shall have all accessories and supports removed with it, whether indicated or not. In addition, any refrigeration containing equipment that is shown for removal shall have all refrigerant evacuated from the system and properly disposed of and all refrigerant piping removed from the site. Refrigerant recovery shall be performed by a technician certified in the maintenance, service, repair, and disposal of refrigerant containing equipment per EPA.

E. Any equipment, piping or ductwork that has been removed in the project and has left an opening and/or anchor points in a floor, wall or roof shall have the openings and voids infilled to match existing conditions.

1.16 GUARANTEE

A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.17 INSTALLATION

A. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.

B. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

C. Layout of equipment, accessories and piping systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or piping systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.

D. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

1.18 STORAGE OF MATERIALS

A. For all ductwork, piping and insulation brought to the jobsite, it shall be protected from all environmental elements. This shall include, but not limited to, water, dust, chemicals and other hazardous materials. It shall be stored within a protected area in the building.
B. All ductwork onsite shall have a wrap on it to prevent the duct from having any dust, debris or other hazardous materials from becoming adhered to the interior of the duct. No duct may be stored where it could be rained on. Also refer to section 233330, low velocity ductwork, for additional information.
C. All insulation on the jobsite will be stored in an area that will protect it from weather damage.

1.19 START UP

A. A start up shall be performed for all new MECHANICAL equipment (MECHANICAL equipment shall be defined here as any MECHANICAL unit that requires power or a temperature controls connection). The manufacturers representative will be onsite and unit operation will be verified, including but not limited to air flow, heating and cooling setpoints are attained and unit functions within manufacturers parameters. A written report shall be furnished to the architect.

1.20 TESTING AND INSPECTION

A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.

B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

C. Required local or municipal inspection processed and present Owner with certificate indicating approval of such governing bodies.

D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.

1.21 RECORD DOCUMENTS

A. When required by general conditions or other Division 1 Section, this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.

B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.22 IDENTIFICATION AND NAMEPLATES

A. Provide engraved plastic labels screwed to all MECHANICAL equipment furnished under this contract including but not limited to: pumps, air handling units, rooftop units, exhaust fans, condensing units, control panels, starters, switches, panels, etc. Labels shall have black background, white letters; minimum letter height 3/8" high, self adhesive labels or punch tape type labels are not acceptable.

1.23 PENETRATIONS THRU FIRE RATED CONSTRUCTION

A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.

B. All piping penetrations through walls, floors, etc. shall be sleeved.

C. All ductwork penetrations shall be furnished with trim frames.

D. All piping and ductwork penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations (exposed surfaces around pipes and ductwork) shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.24 CONFINED SPACES

A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.

B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.25 COORDINATION

A. Layouts of duct and piping systems shown on contract drawings are diagrammatic. Actual duct and piping layouts shall be coordinated in the field by the contractor. Ductwork shop drawings shall be submitted for approval (see next section for coordination drawings if applicable). Coordinate with other trades and with existing conditions, as required for proper installation of all systems. Contractor shall verify that ductwork and piping layouts are coordinated with all other construction trades which might cause a conflict. Any changes due to systems not being properly coordinated shall be the contractor's responsibility.

B. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during coordination drawings are the responsibility of the contractor at NO additional cost.

C. NOTE: Ductwork and piping drawings will NOT be given to the contractor since it is expected of the contractor to field verify and draw the ductwork and piping.

D. Refer to section 013100 Project management and coordination for obtaining cad files from the architect.

E. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during shop drawings are the responsibility of the contractor at NO additional cost.

END OF SECTION

SECTION 23 00 10

CONCRETE WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Concrete mix designs.
B. Reinforcing materials.
C. Shop drawings for reinforcing arrangements.
D. Concrete test reports.

1.3 QUALITY ASSURANCE

A. Comply with provisions of the following, specifications and standards, except where more stringent requirements are specified:
   1. The American Concrete Institute (ACI) "Manual of Concrete Practice".
   2. Applicable ASTM Standards.
   3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Concrete Practice".

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Metal forms shall be clean, free from rust and free from dents.

B. Form lumber shall be new when used for the first time on this job.

C. Plywood shall comply with United States Product Standard PS-1 for Plyform Class 1, Structural 1, Exterior Grade B-B or better.

D. Form coating compounds shall be of a commercial formulation that shall not bond with, stain or adversely affect the concrete surface. Confirm that any form coatings to be used are compatible with any concrete finish to be applied.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars (ReBar) - ASTM A615, Grade 60, deformed, shop fabricated.

B. Welded Wire Fabric (WWF) - ASTM A185, Welded steel wire fabric, in flat sheets only.

C. Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening Reinforcing Bars and Welded Wire Fabric in place. Use wire bar type supports complying with CRSI Class III recommendations.

D. For slab-on-grade use supports with sand plates or horizontal runners where chair legs will damage vapor barrier.

2.3 CONCRETE AND GROUT MATERIALS

A. Cement shall conform to ASTM C-150 Type I.

B. Normal weight concrete aggregates shall conform to ASTM C-33.

C. Concrete shall conform to ASTM C-94 for Ready Mix Concrete. Concrete shall have a minimum 28 day compressive strength of 3000 psi using a minimum of six sacks of cement per cubic yard. The slump for all concrete shall not exceed 4".

D. Time limit for concrete delivery truck shall be a maximum of 45 minutes.

E. Admixtures shall be compatible with all other materials to be used and shall meet the following:
   1. Air-entraining agent shall conform to ASTM C260. Air entrainment shall be between 5% and 7% in all concrete exposed to freezing and thawing.
   2. Chemical admixtures shall conform to ASTM C494 and must be specifically approved by Architect prior to their inclusion into any concrete. Calcium chloride shall not be used in any form.

F. Grout shall be non-shrink, non-metallic, high strength (5000 psi minimum at 28 days) cementitious material.

2.4 RELATED MATERIALS

A. Moisture retaining cover shall comply with ASTM C171, including waterproof paper, polyethylene film and coated burlap.

B. Absorptive cover shall be burlap cloth from jute or kenot, weighing approximately 9 oz. per sq. yard complying with AASHTO M182, Class 2.

C. Water resistant barrier consisting of heavy kraft papers laminated together with glass-fiber reinforcement and over-coated with black polyethylene on each side.

D. Vapor barrier consisting of seven-ply membrane with reinforced core and carrier sheet with fortified bitumen layers, protective weathercoating and plastic anti-stick sheet. Water vapor transmission rate of 0.00 grains per sq. ft. per hour when tested according to ASTM E 96, Method B. Provide manufacturer's recommended mastics and gusset tape.

E. Bonding agents shall be a 2 part, high modulus, moisture insensitive, polysulfide free, rigid epoxy containing 100% solids and shall conform to ASTM C-881, Type 2, Grade 2, Class B; ASTM C-883; ASTM D-638 and ASTM D-695.

F. Provide for installation of inserts, sleeves, fastening devices, dowels, etc. as required.

2.5 TESTING

A. Independent testing laboratory shall prepare cylinders, transport for lab cured specimens, perform all testing, and submit written test reports.

B. Sample fresh concrete (ASTM C172) at time of delivery.

C. Slump (ASTM C143) one test for each days pour for each class of concrete.

D. Air content (ASTM C231), pressure method for normal weight concrete, one test for each days pour or each time compression test cylinders taken.

E. Compression test specimens (ASTM C31), 4 standard cylinders. Stone and cure at testing laboratory. Prepare one set for each truck. Log locations of each test specimen.

F. Compressive strength testing (ASTM C39), first test at (7) days, second test at (14) days, third test at (28) days and fourth cylinder held in reserve for backup testing if required.

G. Test reports shall indicate name of testing company, cylinder identification, sample location, date of placement, concrete type, design strength, actual strength.

PART 3 - EXECUTION

3.1 CONCRETE PADS

A. All new concrete housekeeping pads shall be a minimum of 4" thick. Provide wire mesh in concrete pad. Provide bonding agent on floor and pin new concrete pad to existing concrete floor (minimum of four pins for a 48"x48" pad)

B. Provide concrete pads for all equipment in boiler room, whether indicated on drawings or not.

3.2 FORM WORK

A. Forms shall be constructed to conform to the required shapes, dimensions, line elevations and positions and shall be maintained sufficiently rigid and tight to prevent deformation under load and to eliminate cement leaks. Form surfaces shall be thoroughly cleaned for each use. Forms shall be oiled before reinforcing steel is placed.

B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Bevel wood inserts for forming key-ways, recesses, etc. for easy removal.

C. Coordinate form-work installation with other trades.

3.3 REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

B. Accurately position, support and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers as required.

C. Place reinforcement to obtain at least minimum coverages of concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations.

D. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.4 CONCRETE PLACEMENT

A. Pre-Placement Inspection: Before placing concrete, inspect and complete framework installation, reinforcing steel and items to be embedded or cast-in. Moisten wood forms immediately before placing concrete where form coatings are not used.

B. General: Comply with ACI 304, as herein specified.
   1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

C. Placing concrete in forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer in still plastic to avoid cold joints.
   1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.
   2. Do not use vibrators to transport concrete inside forms.

D. Placing concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
   1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. do not disturb slab surfaces prior to beginning finishing operations.
   3. Maintain reinforcing in proper position during concrete placement operations.

E. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306.

F. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305.

3.5 SURFACE FINISHES

A. Rough Form Finish: For formed concrete surface "below grade" not exposed-to-view. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

B. Trowel Finish: Apply trowel finish to interior equipment and housekeeping slab surfaces to be exposed-to-view. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as a trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance and with a surface plane tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge. Grind smooth any surface defects.

C. Non-Slip Broom Finish: Apply to exterior above or at grade slab surfaces. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to the short edge and finish slab perimeters with an edging tool.

D. Equipment Support Base Finish: Concrete surfaces of equipment support bases shall be finished per equipment manufacturer's recommendations.

E. Piers Finish: Top of piers shall be shaped to shed water and finish for support leg or equipment mount shall be per equipment manufacturer's recommendations.

3.6 CONCRETE CURING AND PROTECTION

A. Curing shall be accomplished by preventing loss of moisture, temperature change greater than 5°F in one hour to 50°F in any 24 hours, mechanical injury, or injury from rain or flowing water for a period of not less than 7 days. Curing compounds, if used shall be checked for compatibility with all finish coats.

B. Curing shall be started as soon as free water has disappeared from the concrete after placing and shall be accomplished by keeping the concrete surfaces damp. Where formed surfaces are cured in the forms, the forms shall be kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued with moisture-cover curing method as described below.

C. Cover concrete slab surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.7 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension and holes left by tie rods and belts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to the satisfaction of the Engineer. Surface defects include: irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface. Flush out form tie holes, fill with dry pack mortar.

END OF SECTION

SECTION 23 05 23

PIPING SYSTEM VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of valves and service.
B. Product data for all valves.

1.3 REFERENCE STANDARDS AND CODES

A. All installations and materials shall conform to applicable 2020 New York State Building Code, and local building and plumbing codes.

B. All installations shall conform to requirements of Owner's Insurance carriers.

C. Refer to the latest edition and applicable sections of the following:
1. Underwriters Laboratories (UL)
2. American Society of Testing and Materials (ASTM)
3. American National Standards Institute (ANSI)
4. American Society of Mechanical Engineering (ASME)
5. Code for Pressure Piping B31.9 - Building Services Piping
6. American Welding Society (AWS)
7. National Fire Protection Association (NFPA)
8. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS)

1.4 GENERAL REQUIREMENTS

A. Ensure valves are dry and internally protected against rust and corrosion. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.

B. Protect valve ends against damage to threads, flange faces and weld-end preps.

C. Do not use hand-wheels and stems as lifting or rigging points.

D. All valves and terminal water specialties shall be same size as upstream piping, unless otherwise indicated.

E. Furnish valves with pressure and temperature ratings as specified and required to suit system pressures and temperatures.

F. Furnish valves with either threaded, flanged or solder-joint end connections as specified.

G. Furnish chain wheel operators for valves 6" and larger when valve is to be mounted 8' or higher above finished floor elevations.

PART 2 - PRODUCTS

2.1 VALVE SCHEDULE

A. Note: Specialty valves specified in other sections.

	Pipe Fill	Pipe Size	Valve Type
1.	Heating Hot Water	Up to 2"	BV-1
2.	Heating Hot Water	2-1/2" & Over	WV-1
3.	Heating Hot Water	Up to 2"	CBV-1
4.	Heating Hot Water	2-1/2" & Over	CBV-2
5.	Heating Hot Water	Up to 2"	CKV-1
6.	Heating Hot Water	2-1/2" & Over	CKV-2
7.	Condensate Drain	Up to 2"	BV-1
8.	Condensate Drain	2-1/2" & Over	WV-1
9.	Cold Water Makeup	Up to 2"	BV-1
10.	Cold Water Makeup	Up to 2"	CKV-1
11.	Cold Water Makeup	2-1/2" & Over	CKV-2
12.	Cold Water Makeup	2-1/2" & Over	WV-1

B. Valve Types

1. BV-1: Ball valve, size as required, sweat or threaded ends, forged bronze body, hard chrome plated ball, glass reinforced durafill seats, PTFE stem packing, 600 psi WOG non-shock, 150psi WSP for ¼"-2", 450°F (@50psi) maximum temperature. Brass body is not acceptable and will be rejected. Series #B6000, B6001, Watts Regulator Co.; or equal.
2. CBV-1: Circuit balancing valve, size as required for nominal 3ft WG pressure drop. Note: the submitted pressure drop shall not exceed 2ft. The TAB contractor shall balance to 3ft. Y-pattern Style design and all metal parts of nonferrous, pressure die cast, nonporous Ametal copper alloy and high strength resin hand-wheel and sleeve. Provides a positive shut-off. Provision for connecting a portable differential pressure meter. Each meter connection shall have pressure/ temperature readout ports. Rubber O-ring disc to ensure positive shut-off. Valve shall provide multi-turn, 360° adjustment, digital handwheel with hidden memory feature to set the valve with precision tamper-proof setting. Model STAD, rated at 300 psig, 250°F, TA Hydronics; or equal.
3. CBV-2: Circuit balancing valve, size as required for nominal 2 ft WG pressure drop. Flanged, Y-pattern Style design with ductile iron body and other metal parts of nonferrous copper alloy and high strength resin hand-wheel and sleeve. Provides a positive shut-off. Provision for connecting a portable differential pressure meter. Each meter connection shall have pressure/ temperature readout ports. Rubber O-ring disc to ensure positive shut-off. Valve shall provide multi-turn, 360° adjustment, digital handwheel with hidden memory feature to set the valve with precision tamper-proof setting. Model STAF, rated at 250 psig, 250°F, TA Hydronics; or equal.

4. CKV-1: Check valve, bronze body, bronze disc. rated at 200 psi, non-shock for 2" and smaller. Nibco Model #T-413; or equal.
5. CKV-2: Check valve, iron body, bronze disc. rated at 200 psi, non-shock, flanged connections for 2-1/2" and larger. Nibco Model #F-918; or equal.
6. FCV-1: **ADJUSTABLE** Automatic flow control valves. Valve gpm shall be factory set and shall automatically limit flow to within 5% of specified rate. For 3/4" to 2" valves flow cartridge shall be removable from valve housing without the use of special tools to provide access without breaking main piping. Cartridge flow rates shall be externally adjustable while system is in operation with 41 flow rate settings range per cartridge. A true design operating pressure (psid) range of 4.4 – 58 psi is required. Each valve should have 2 P/T ports. All automatic flow control valves shall be provided by single source with certified flow tests. Internal wear surfaces of the valve cartridge shall be stainless steel. The cartridge body shall have machined threads to compensate for the spring free height. Fixed shims are not acceptable. Cartridges shall be color coded to determine model type and GPM Range and a flow rate chart for external adjustment of flow rate settings shall be provided. For 3/4" to 2" valves, valve assembly shall consist of Y type body and O-ring union. 2-1/2" to 6" valves shall be flanged wafer style valves and shall be externally adjustable while system is in operation with 51 flow rate settings per valve insert. Static pressure rating of 580 psi with a temperature rating of 248 F. Valve shall be E-just, by FlowCon International.; B&G; or approved equal. **NOTE: It is the intent that an externally adjustable valve is used to simplify installation, so the balancer can set the flow and ensure that the correct flow is achieved.**
7. FCV-2: **NON-Adjustable**, Automatic flow control valves. Valve gpm shall be factory set and shall automatically limit flow to within 5% of specified rate. For 3/4" to 2" valves flow cartridge shall be removable from valve housing without the use of special tools to provide access without breaking main piping. A true design operating pressure (psid) range of 4.4 – 58 psi is required. Each valve should have 2 P/T ports. All automatic flow control valves shall be provided by single source with certified flow tests. Internal wear surfaces of the valve cartridge shall be stainless steel. The cartridge body shall have machined threads to compensate for the spring free height. Fixed shims are not acceptable. Cartridges shall be color coded to determine model type and GPM Range and a flow rate chart for external adjustment of flow rate settings shall be provided. For 3/4" to 2" valves, valve assembly shall consist of Y type body and O-ring union. 2-1/2" to 6" valves shall be flanged wafer style valves. Static pressure rating of 580 psi with a temperature rating of 248 F. Valve shall be Griswald K-valve; or approved equal.
8. WV-1: Butterfly valve (HW, CHW as indicated) 2" – 12" size as required,. One piece cast iron **LUG** style body ANSI class 125/150, extended neck, Stainless Steel disc with polished edges, one piece stainless steel stem, triple function molded-in EPDM seat, upper and lower stem bearings, NBR (Buna) upper stem seal, bubble-tight shutoff, temperature range of -20o F to 250o F, pressure rating of 250 psi bi-directional. Keystone Figure 222; or equal.
    a) Grooved end valve: 300 psi CWP suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full

360 degree seating. Seat shall be pressure responsive EPDM. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be lever handle or gear operator, available with memory stop feature, locking device, chainwheel, or supplied bare. Basis of Deign: Victaulic S/761

PART 3 - EXECUTION

3.1 GENERAL

A. Install all valves per manufacturers recommendations.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS:

A. Description of intended testing procedures.
B. Blank data forms indicating all intended test data points.
C. Written statement of coordination with sheetmetal contractor.
D. Written statement of coordination with piping contractor.
E. Written statement of acceptance of location and quantity of air and water balancing devices.
F. Pre-balance information from existing systems, where required.

1.3 QUALIFICATIONS

A. Acceptable Subcontractors are:
   1. Member contractors of "Associated Air Balance Council".
   2. Member contractors of "National Environmental Balancing Bureau".

B. Procedures and Methods: Follow written procedures published, one or more of following:
   1. Associated Air Balance Council (AABC).
   2. National Environmental Balancing Bureau (NEBB).

1.4 SCOPE OF WORK

A. Contractor shall perform testing, balancing and adjusting work on all new and existing equipment shown on plans, listed in this section and as required by applicable sections of the specification. Note: All existing equipment used in new or renovated systems is required to be tested adjusted and balanced.

B. Note: Air side systems shall be balanced prior to water balance.

C. Testing, adjusting and balancing is required for all of the following:
   1. Air Side Equipment:
      a) Air Handling Units
      b) Supply, Return, Exhaust and Relief Duct Systems
      c) Terminal Equipment
      d) Diffusers, Registers and Grilles
   2. Hydronic Equipment:
      a) Pumps

b) Air Handling Unit Coils
c) Terminal Equipment Coils
d) Piping Distribution Systems
e) Terminal Radiation Units

1.5 GENERAL REQUIREMENTS

A. It shall be responsibility of the Contractor to place all systems in satisfactory operating condition, including providing services of approved adjusting and balancing subcontractor regularly engaged in this type of work.

B. Furnish set of Bid Documents to subcontractor within ten (10) days after award of contract.

C. Adjusting and balancing shall be accomplished as soon as possible after systems are complete and before Owner takes possession.

D. All systems must conform with the following noise criteria:
1. Areas shall have NC30 to 35.

E. Initial adjustment and balancing to quantities indicated on design drawings and thereafter as required to satisfy job conditions to satisfaction of the Architects.

F. Adjusting and balancing shall be accomplished under appropriate outdoor temperature conditions.

G. Immediately prior to subcontractor's arrival on project:
1. Adjust all balancing cocks and dampers open.
2. Place all equipment in operating condition.
3. Clean all strainers.
4. Remove all temporary air filters and install design filters.

H. During course of the adjusting and balancing work:

I. Maintain qualified personnel at project at all times for system operation, trouble shooting, assistance, etc.

J. Change pulleys and belts as required to meet system performance requirements. Adjustable sheaves shall not be operated at extreme end of adjustment. Replace adjustable sheaves with proper size to operate approximately in mid-range.

K. Perform necessary mechanical adjustments in conjunction with balancing procedure.

L. Replace all flow balancers in new and existing systems that cannot be manipulated to satisfy balancing requirements.

1.6 JOB VISIT

A. Balancing subcontractor shall visit job prior to concealment of work and advise location of dampers, test connections, etc.; advise Architects by letter.

B. Make any changes or additions of types, locations, etc. of balancing facilities.

1.7 FINAL REPORT

A. Upon completion, all information shall be inserted in report form listing all items required by specifications. Entire report shall be typewritten and shall be submitted to Architect and Engineer for approval. Results shall be guaranteed. Provide (3) hard copies and electronically submit to architect.

B. Complete balancing analysis on all individual equipment and systems as specified shall be included in report.

C. Contractor shall be subject to recall to site to verify report information before approval of report by Architects.

D. Record action taken to adjust all systems to meet design specifications.

E. Report on condition of installations (i.e. - complete/inoperative etc.)

F. Final reports which do not contain all data required by this section will be rejected. Contractor will be required to retest and resubmit for all applicable systems with missing information.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide all tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers, tachometers, etc. required to execute the work. Instruments used shall be accurately calibrated.

1. NOTE: IF VFD IS PROVIDED, CONTRACTOR SHALL USE VFD FOR BALANCING OF AIR OR HYDRONIC EQUIPMENT. SYSTEM TO BE BALANCED WITH TDV COMPLETELY OPEN.

PART 3 - EXECUTION

3.1 AIR AND HYDRONIC SYSTEMS

A. Preparation:
1. Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bid.
2. The balancing subcontractor shall review sheetmetal shop drawings and mark the location of all required balancing dampers before duct fabrication.
3. Written notice of coordination between Contractor and balancing contractor to be submitted to Architect and Engineer.

B. Requirements for Air-Side Testing, Adjusting & Balancing:
1. Air Handling Equipment:
a) Record all drive information (i.e. - sheave type, belt size, motor data).

b) Test and adjust fan rpm to design requirements.
c) Record RPM and final sheave position.
d) Test and record motor no load, and full load amperes, and determine operating brake horsepower.
e) Test and record inlet and discharge static pressures.
f) Test, adjust and record SA, RA, OA and relief air flows for design recirculated air cfm.
g) Test, adjust and record SA, RA, OA and relief air flows for full design outside air cfm. Make special effort to test and record total relief cfm air.
h) Test and record entering and leaving air temperatures. (D.B. heating and cooling)
i) Test and record equipment sound levels in closest occupied space.

2. Ductwork & Air Distribution Systems:
   a) Adjust all main supply, exhaust and return air ducts to proper design cfm, supply, exhaust, return and relief.
   b) Test and adjust each diffuser, grille, and register to within 10% of design requirements.
   c) After grilles, diffusers and registers are set at final CFM, check and record sound levels at occupant level at all locations.
   d) Each grille, diffuser, and register shall be identified as to location and area.
   e) Size, type and manufacturer of diffusers, grilles and registers, and all tested equipment shall be identified and listed; manufacturer's ratings on all equipment shall be used to make required calculations.
   f) Readings and tests of diffusers, grilles and registers shall include required fpm velocity and test resultant velocity, required cfm and test resultant cfm after adjustments.
3. Terminal Units:
   a) Adjust terminal units to cfm.
4. Fans (Supply & Exhaust):
   a) Record all drive information (i.e. - sheave type, belts, size, motor data).
   b) Test and adjust fan rpm to design requirements.
   c) Record cfm, rpm and final sheave position.
   d) Test and record motor no load and full load amperes and determine operating brake horsepower.
   e) Test and record inlet and discharge static pressures.
   f) In cooperation with control manufacturer's representative, make mechanical adjustments of automatically operated dampers to operate as specified, indicated, and/or noted; subcontractor shall check these damper control operations for proper calibrations and list those requiring adjustment by control installers.
   g) All diffusers, grilles and registers shall have air patterns adjusted to minimize drafts in all areas.
   h) A record of all final settings shall be made, preferably at each piece of equipment by an appropriate approved mark or if necessary by description on the report schedule.
   i) Record all space temperatures. If space temperatures vary more than 2°F from thermostat setting readjust air flows to obtain proper temperature.

C. Requirements for Water Systems Testing, Adjusting & Balancing:

1. Initial Procedure:
   a) Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bids.
   b) Air systems shall be examined first.
   c) Open all manual valves to full open position; close coil bypass stop valves; set automatic control valves to full coil flow.
   d) Examine water in system and determine if water has been treated and cleaned.
   e) Check expansion tank and/or compression tanks to determine if they are not air bound or water logged and system is full of water and a proper minimum fill pressure.
   f) Check all air vents at high points of water systems and determine if they are installed and operating freely.
   g) Balance terminal units furthest from pumps, work towards pumps. Final balance pump flow control valve(s) last.
2. Pumps:
   a) Prior to balancing ensure all strainers and dirt pockets have been cleaned.
   b) Check pump rotation.
   c) Set hot water pumps to proper gallons per minute delivery.
   d) Record and check the following items at each heating element:
      (1) Pressure drop across bypass valve.
      (2) Pump operating suction and discharge pressures & final TDH.
      (3) List all mechanical specifications of pumps.
      (4) Rated and actual running amperage of pump motor.
3. Piping Distribution System:
   a) Test and adjust all flow control devices.
   b) Record final settings and distribution gpm.
   c) Test and record pressure on non adjustable flow control valves. Verify pressure is within control range on valve.
4. Hydronic Coils:
   a) Set all temperature controls so all coils are calling for full flow.
   b) After adjustments to coils are made, recheck settings at pumps and readjust as required.
   c) Read pressure and differential across coils and set flow rate on coil for full heating; set pressure drop across bypass valve to match coil full flow pressure drop.
   d) Record and check the following items at each heating element:
      (1) Inlet water temperature.
      (2) Leaving water temperatures.
      (3) Pressure drop.
   e) Check water temperatures at outlet side of heating coils; Note: drop of temperature from source.
   f) Upon completion of flow reading and adjustment of coils, mark all settings and record data. Show on schematic sketch form wherever practical.
5. Heat Exchangers:
   a) Check operation of any automatic bypass or diverting valves.

b) Check and set operating temperatures of heat exchanger to design requirements.
c) Record all flows, pressure drops and temperature across heat exchanger.

6. Fin Tube Radiation:
   a) Test, adjust and record gpm for fin tube unit.
   b) For units not equipped with balancing valve, adjust flow across fin tube using temperature drop method.
   c) Record flows or temperature drop readings and flow calculations.

END OF SECTION

SECTION 23 07 13

DUCTWORK INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 WORK INCLUDED

A. Insulate all ducts and as required by contract documents.

1.3 REFERENCES

A. Test standards and reports for evaluating and rating performance of fire rated shaft enclosures and zero inch clearance ratings for duct wrap systems for compliance to Code.
   1. ISO 6944-1985, 'Fire Resistive Tests - Ventilation Ducts'.
   2. ASTM E 2336, 'Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems'.
   3. ASTM E 814 (UL1479), 'Fire Tests of Through-Penetration Fire Stops Standard'.
   4. ASTM E 84, 'Standard Test Method for Surface Burning Characteristics of Building Materials'.
   5. ASTM C 1338, 'Fungi Resistance of Insulation Materials and Facings Standard'.
   6. NFPA 96 'Standard for Ventilation Control & Fire Protection of Commercial Cooking Operations'.

1.4 SUBMITTALS

A. Manufacturer data for all materials used in contract. Submit schedule of insulation applications.

PART 2 - PRODUCTS

2.1 DUCTWORK INSULATION

A. NOTE: IF A CONDITION IS NOT LISTED BELOW, IT SHALL BE INSULATED WITH 2" RB.

B. All exhaust fan and relief hoods shall have the void between the duct and the curb completely insulated with FB insulation.

C. All relief/intake hoods, goosenecks, louvered penthouses and any other ductwork that has exterior termination that have exposed surfaces inside the building shall be insulated as outside air ductwork.

D. The following is a schedule for ductwork insulation:

	Duct System & Location	Type	Thickness	Notes
1.	Outside Air, Relief Air, and Exhaust Air Ducts & Plenum Exposed to Air at Outside Ambient Temperatures (For All Air Handling and Energy Recovery Units), Energy Recovery Exhaust:			
	a) Concealed Spaces	FB	3"	(2)
	b) Exposed Spaces	RB	2"	(1)
2.	Supply & Return Duct:			
	a) Concealed Spaces	FB	2.2"	(2)(4)
	b) Exposed Spaces	RB	2.2"	(1)(4)
3.	Return Duct within a plenum ceiling	NONE		(6)
4.	Exhaust Fan Ductwork	FB	3"	(2)(5)
	a) Between the backdraft or mechanical damper and the space (ductwork having room conditioned ductwork), no insulation is required. All other exhaust ductwork (or if there is no damper present) shall be insulated as outside air ductwork.			
	b) This does not apply to energy recovery units, refer to above for all energy recovery units.			
5.	Duct Coils (coil & duct 3'-0" min. upstream & downstream, including the coil)	FB	2.2"	(2)
6.	All Exterior Ductwork	ERB	3"	(3)(7)(8)(9)

Schedule Notes [some notes might not be used]:

(1) Weld pins with tapered joints.

(2) Stapled edge with mechanical fasteners on ducts over 24" wide.

(3) Provide insulation whether duct is lined or not

(4) Ducts with internal liner do not require additional insulation unless otherwise noted. This does not apply to special 14 gauge supply duct.

(5) Exhaust duct exposed to air at ambient temperature must meet the requirements listed above.

(6) Provide continuous, water tight jacketing over all exterior ductwork.

(7) For ductwork over 24" wide, pitch insulation towards sides of duct.

(8) Pitch insulation at equipment connections away from equipment to prevent pooling and intake of water.

(9) Exterior insulation is not required on return ductwork contained within areas with a ceiling acting as a plenum return – provide exterior insulation per schedule on return ductwork when outside of areas of plenum return.

E. Duct insulating materials shall be as follows:

1. FB: Flexible fiberglass blanket type duct wrap with factory applied foil faced jacketing reinforced with fiberglass scrim laminated to UL rated kraft. Minimum thickness = 2.2in. Insulation shall be 0.75-lb/ft3 with a thermal conductivity (k-value) of 0.27 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature when compressed. Provide with 2" stapling tab. Provide Type #75, Johns Manville; or equal.

2. RB: Factory fabricated rigid fiberglass board with factory applied white kraft facing bonded to aluminum foil, reinforced with fiberglass yarn. Minimum thickness = 2in. Temperature limit 450°F unfaced side, 3.0 lb./cu. ft. density. Thermal conductivity (k-value) of 0.23 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature. Insulation to have a R value of 4.3 per inch. Type #814, Johns Manville; or equal.

3. ERB: Furnish and install 3" thick, closed-cell polyisocyanurate foam core board with foil facing on all ductwork segments and fittings installed outside of the building. Board shall have a R-value of 19 (for a 3" thick sheet). Board shall act as a vapor barrier with a vapor permeance of 0.05 perms. Provide Johns Manville AP Foil Faced; or equal.

F. Jacketing Material shall be Venture Clad 1579GCW-E as manufactured by Venture Tape; or approved equal. To be applied over all exterior ductwork insulation or exterior lined ductwork, and as noted elsewhere.
   1. Jacketing material shall have a 16.0 mils thickness, 13-ply embossed aluminum made with (2) layers of aluminum foil, a layer of polyester film, an outer layer of tedlan film and an acrylic pressure sensitive adhesive layer.
   2. Jacketing material to provide a 10 year membrane warranty, to be UV resistant and have zero permeability.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK INSULATION

A. All insulation, jacketing and accessories are to be installed in strict accordance with manufacturer's instructions.

B. Flexible Blanket Insulation (FB): Insulation shall be tightly wrapped around ductwork with all circumferential joints butted and longitudinal joints overlapped minimum of 2".
   1. Adhere insulation to metal with 4" wide strips of insulation bonding adhesive at 8" on center and, on ductwork over 24" wide, additionally secure insulation to bottom with pins welded to duct 18" on center. On circumferential joints, secure 2" flange of facing using 9/16" flare door staples applied 6" on center and tape with 3" wide foil reinforced kraft tape. On longitudinal joints, secure overlap in the same manner. All pin penetrations or punctures in facing shall be similarly taped. If single blanket or sufficient thickness is not available, install two layers of equal thickness with vapor barrier facing on outer layer only.

C. Rigid Board Insulation (RB): Impale insulation over pins welded to duct on 21" centers, cut to extend 1/8" beyond face of board and cover with vapor seal mastic and self-locking cap. Seal all edges and butt joints with 5" wide strips of self-sealing pressure sensitive tape matching surface and finish of duct insulation.

D. Exterior Ductwork Insulation. Polyisocyanurate Board (ERB): Apply adhesive according to manufacturer's recommended coverage rates per area. Insulation to be adhered to ductwork with weld pins with tapered joints and adhesive, see below. Impale insulation over pins welded to duct on 21" centers, cut to extend 1/8" beyond face of board and cover with vapor seal mastic and self-locking cap. Seal all edges and butt joints with 5" wide strips of self-sealing pressure sensitive tape matching surface and finish of duct insulation. Insulation is to be applied to ductwork with joints tightly butted. All joints shall be fitted to eliminate voids. Any voids are to be eliminated by refitting or replacing sections of insulation.
   1. Provide polyisocyanurate board on top, sides and bottom of duct with adhesive.

2. For ducts over 24", apply sloped polyisocyanurate insulation (Hunter board H-shield; or equal) over Polyisocyanurate insulation to provide a 12/1 pitch in the center of the duct to prevent snow buildup. Attach Polyisocyanurate insulation together with adhesive.
3. Insulate bottom of duct first, full width of duct.
4. Insulate sides next, same height as duct plus thickness of bottom sheet insulation.
5. Insulate top full width of duct plus thickness of side sheets both sides.
6. This contractor shall have a manufacturer's insulation representative instruct his personnel on the installation of this insulation and must be on the site the first day to review the installation.

E. Jacketing: Jacket to be applied to all surfaces of insulation and duct. Jacket to overlap previous section by minimum of 2".

END OF SECTION

SECTION 23 07 16

EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Manufacturer data for all materials used in contract. Submit schedule of insulation applications.

1.3 WORK INCLUDED

A. Insulate equipment as required by contract documents.

PART 2 - PRODUCTS

2.1 HEATING HOT WATER EQUIPMENT

A. Hot Water Heat Exchanger: Insulate all exposed surfaces with 2" thick, unfaced calcium silicate block, Thermo-12 Gold, Johns Manville; or equal. Insulation shall have thermal conductivity of 0.39 BTU-in./hr-sq.ft.- °F at mean temperature of 200°F. Maximum operating temperature 1200°F.

1. Provide mechanical stud fasteners, galvanized 2" hexagonal wire mesh and 16 gauge galvanized annealed steel tie wire.
2. Insulating and finishing cement shall be hydraulic setting, low shrinkage, quick hardening, paintable.

B. Hot Water Air Separator: Furnish 1" thick flexible, elastomeric thermal insulation: Armstrong Armaflex II Sheet & Roll Insulation; or equal. Insulation to have flame spread rating of 25 or less and smoke developed rating of 200 or less. Temperature range to be -40°F to 220°F. Apply adhesive to total surface and attach insulation to all exposed surfaces: in this case, maximum surface temperature to which adhesive is applied may be 180°F. Adhesive to be Armstrong #520 Adhesive; or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install insulation system in strict accordance with manufacturer's instructions.

END OF SECTION

SECTION 23 07 19

PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of all materials used.

B. Product data for all materials.

1.3 WORK INCLUDED

A. Insulate all pipes as required by contract documents.

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. NOTE: IF A CONDITION IS NOT LISTED BELOW, IT SHALL BE INSULATED WITH 1-1/2" TYPE A OR TYPE B, DEPENDING ON THE PIPE.

B. The following is a schedule for pipe insulation:

System Type		Pipe Diameter Up To 1-1/4" Min. Insulation Thickness	Pipe Diameter 1-1/2" & Larger Insulation Thickness	Type	Notes
1.	Heating Hot Water	1-1/2"	2"	A	(1)(2)(3)(5)(6)
2.	Condensate Drain	1/2"	1/2"	B	(4)
3.	Condenser Water	1/2"	1"	A	(1)(2)(3)
4.	Cold Water Make-up	1/2"	1/2"	A	(1)(2)
5.	Refrigerant Suction, Liquid Piping and Hot Gas Bypass				
	a) INTERIOR	1/2"	1/2"	B	(4)(7)
	b) EXTERIOR	1"	1"	B	(4)(5)

Schedule Notes:

(1) Pre-Molded PVC Fitting Covers: Zeston, Inc.; or equal.
(2) Self-seal lap.
(3) Staples-outward clinching.
(4) Foamed plastic pipe insulation adhesive; Armstrong Co.; 520 adhesive; or equal as required to ensure there are no gaps in insulation.

(5) Exterior insulation shall be covered with exterior jacketing (venture clad) as specified hereinafter. All piping shall be supported to prevent sagging of the pipe, provide supports as required.
(6) Furnish high impact strength PVC piping jacketing, as specified hereinafter, for all exposed piping in all finished spaces.
(7) Provide manufacturers pre-insulated line sets with flare connections where possible. Provide rubber insert cushy clamps for all unistrut piping risers and hydra-zorb insulation unistrut cradles for horizontal piping. Ensure all piping is insulated with no gaps.

C. Equipment Insulation:
1. All hot water and chilled water fittings, valves, water specialties, flanges, air separators and pumps shall be insulated per this section, NO EXCEPTIONS!
2. Note: Do not run any insulation through pitch pockets.
3. Note: All insulation requirements of this section shall apply to flexible expansion joints (EXP-1).

2.2 MATERIALS FOR PIPING INSULATION

A. Pipe insulating materials shall be as follows:
1. Type A: Fiberglass pipe insulation jacketed with a reinforced vapor retarder jacket and factory applied longitudinal acrylic adhesive closure system. Insulation shall have a maximum service temperature of 850°F with a thermal conductivity (k-value) of 0.23 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature per ASTM C518 and UL rated for maximum flamespread of 25 and smoke developed of 50. Johns Manville. Micro-Lok; or equal.
2. Type B: Closed Cell Foam Pipe Insulation. Insulation shall have a maximum service temperature of 300°F with a thermal conductivity (k-value) of 0.28 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature per ASTM C518 and UL rated for a maximum flamespread of 25 and smoke developed of 50.
a) Pre-slit foamed plastic pipe insulation with slit positioned at side and vapor sealed with adhesive on all joints. AP Armaflex Tube Insulation; or equal.

B. High Impact Strength Jacketing: Furnish PVC jacketing and fitting covers, conforming to ASTM E-84; flame spread 25, smoke developed 50, white high gloss finish, 0.02" minimum thickness.

C. Furnish pre-molded PVC jacketing and fitting covers, lo-smoke type, as manufactured by Proto Corp.; or an approved equal.

D. Exterior Jacketing: Material shall be Venture Clad 1579GCW-E as manufactured by Venture Tape; or approved equal. To be applied over all exterior piping, and as noted elsewhere.
1. Jacketing material shall have a 24.0 mils thickness, 13-ply embossed aluminum made with (2) layers of aluminum foil, a layer of polyester film, an outer layer of tedlan film and an acrylic pressure sensitive adhesive layer.
2. Jacketing material to provide a 10 year membrane warranty, to be UV resistant and have zero permeability.

PART 3 - EXECUTION

3.1 PIPING INSULATION INSTALLATION

A. Type of Insulation Listed and Methods of Installation:
   1. Fiberglass Pipe Insulation (A): Butt joints sealed with 3" wide strips of jacket material with factory applied pressure sensitive adhesive, laps and strips applied over clean dry surfaces and all longitudinal and circumferential seams rubbed hard with blunt steel edge. Cover valves, fittings, flanges, etc. with pre-formed fiberglass fittings and premolded PVC plastic jackets.
   2. Closed Cell Foam Pipe Insulation (B): Insulate fittings, valves and flanges with mitered and fitted sections of foamed plastic pipe insulation positioned and fastened by adhesive on all joints.

B. Special Requirements:
   1. Heating piping hangers shall be applied directly to piping. Cut-out insulation for hanger and cover with jacketing. Insulation shall be "butt-up" to hanger as tightly as possible.
   2. Cooling/refrigeration piping insulation shall be continuous and have no breaks, insulation shield shall be applied between insulation and hanger.

END OF SECTION

SECTION 23 09 93

TEMPERATURE CONTROLS

PART 1 – GENERAL

1.1 RELATED SECTIONS

A. The General Conditions of the Contract including all modified General Conditions, and Division 1 specification and shall be used in conjunction with this section as part of the contract documents. Consult the above for further instructions pertaining to this work. The Contractor is bound by the provisions of Division 0 and Division 1.

1.2 STATE CONTRACT

A. The existing building automation system at Newark Valley CSD is a Schneider Electric DDC System, installed and serviced by Stark Tech / Day Automation.

B. The temperature control contractors labor shall be bid under the mechanical contractor and the temperature control contractor will be a sub to the MC. The temperature control contractors scope shall include controls installation and wiring, providing operating manuals, start up services, control engineering and training and warranty for factory related issues on equipment and controls.

C. The parts shall be on state contract and the temperature control contractor shall provide a list of equipment that the mc shall need to install prior to bid. All new DDC controls shall be Schneider Electric and connected to the existing system. Stark Tech / Day Automation equipment identified as per schedule and DDC controls will be pre-purchased and supplied for this project via Stark Tech / Day Automation's NYS OGS contract.

D. Equipment will be shipped from the factory to the temperature controls contractor. The equipment will be unloaded, inspected and stored by the TC. Any valves or dampers will be given to and installed by the mechanical contractor.

E. The state contract purchased day equipment and day controls shall include temperature controllers and devices.

F. See specification sections for additional requirements.

G. All other warranty services are by the HVAC contractor.

1.3 CONNECTION TO EXISTING CONTROL SYSTEM

A. All new control equipment must integrate seamlessly with existing Schneider Electric DDC system, installed and serviced by Day Automation. All new digital controllers are required to communicate fully with the existing temperature control network.

B. All new controllers provided under this project must be connected to the existing BAS System. Extend network (including software) as required to provide a fully integrated control system.

C. BAS System Contractor shall modify programming in host computer to accept all new equipment and I/O points.

D. Contractor must visit site to inspect existing equipment required for operation of new systems. If existing miscellaneous equipment is not of sufficient size or is not functioning properly, contractor must include replacement or refurbishment in his bid.

1.4 ACCEPTABLE MANUFACTURERS

A. Maufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Schneider Electric, installed and serviced by Stark Tech / Day Automation.

B. If the Contractor is proposing to provide a product by a Manufacturer other than those listed above, the Contractor must, at least 10 days prior to bid opening, to obtain the approval of the Owner for the equal manufacturer, along with provided 5 references of sites where the company has performed projects to similar type.

1.5 SOFTWARE UPGRADES / SERVER UPGRADES

A. At the completion of the project, the contractor shall ensure that all software is at its latest available revision and that all hardware (servers, workstations, laptops, etc.) shall be capable of meeting all requirements to ensure that the (OWNER) has been furnished with a completely updated system.

B. If replacement of existing hardware is required due to compatibility with the latest revision of software, it shall be the responsibility of this contractor to provide new hardware.

1.6 CONTROL SYSTEM DESCRIPTION

A. Provide labor, controls materials, controls equipment and services as required for a complete BACnet Building Automation System (BAS), to perform the functions described in this Section. Controls System shall be Web-based and accessible either directly connected and/or through the owners IP LAN network.

B. It is the BAS manufacturer's responsibility to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BAS operators have the capability of managing the building mechanical system.

C. The BAS shall meet BACnet communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects. These open protocol communication standards are discussed in more detail later in this specification.

D. BAS controllers shall be listed by BACnet Testing Laboratories (BTL) with appropriate classification.

E. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and equipment on this project.

F. The BAS shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by the security permissions of the operator role. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.

G. The BAS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

1.7 SUBMITTAL REQUIREMENTS

A. BAS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer has reviewed submittals for conformity with the plan and specifications. Five (5) copies are required. All shop drawings shall be provided to the Owner electronically once they have been approved and as-built drawings have been completed.

B. Quantities of items submitted shall be reviewed by the Engineer. Such review shall not relieve the BAS manufacturer of furnishing quantities required based upon contract documents.

C. Provide the Engineer with any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.

D. Submit the following within 45 days of contract award:
   1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.
   2. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.
   3. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.
   4. Note: schedule of valves and dampers shall be submitted independently of other submittals; do not combine with other submittals.
   5. Provide all manufacturers' technical cut sheets for major system components. When technical cut sheets 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. Include:
      a) Building Controllers
      b) Custom Application Controllers
      c) Application Specific Controllers
      d) Operator Workstations
      e) Portable Operator Terminals
      f) Auxiliary Control Devices

6. Room schedule including a separate line for each VAV box and/or terminal unit indicating location and address.
7. Samples of graphic display screen types and associated menus.
8. Provide proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements.
9. Provide detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.
10. Provide points list showing all system objects and the proposed object names.
11. Provide a sequence of operation for each controlled mechanical system and terminal end devices.
12. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the points list for proper coordination of interoperability with other building systems if applicable for this project.

E. Project Record Documents: Upon completion of installation, submit PDF of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:
1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic drawing files shall be provided.
2. Testing and Commissioning Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BAS) commissioning personnel.
3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:
    a) Names, address and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.
    b) Procedures for operating the BAS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements.
    c) Description of the programming language including syntax, statement descriptions, algorithms, calculations, point database creation and modification, program creation and modification, and operator use of the editor.
    d) Explanation of how to design and install new points, new DDC controllers, and other BAS hardware.
    e) Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.
    f) Documentation of all software program logic created for Custom Programmable Controllers including the overall point database. Provide one set of magnetic media containing files of the software and point database.
    g) One set of electronic media containing files of all operator color graphic screens for the project.

h) A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.
i) Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.
j) Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
k) Licenses, Guarantee, and Warranty documents for all equipment and systems.

1.8 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 – Hydronic Piping
1. Control Valves
2. Temperature Sensor Wells and Sockets
3. Hydronic Pressure Taps
4. Hydronic Flow Meters

B. Section 233300 – Ductwork Accessories
1. Automatic Dampers
2. Airflow Stations

1.9 DEFINITIONS

Term	**Definition**
UCP	Unitary Controller
ACP	Air Handler Controller
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing (MS/TP)	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement (PICS)	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.

Term	Definition
UCP	Unitary Controller
Wiring	Raceway, fittings, wire, boxes and related items.

1.10 CODES AND STANDARDS

A. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.
   1. Underwriters Laboratories: Products shall be UL-916-Energy Management Systems for BAS components & ancillary equipment
   2. Underwriters Laboratories: Products shall be UL-873 Temperature Indication & Regulating Equipment.
   3. Federal Communications Commission –Part 15- Subpart J.
   4. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National Standards.
   5. ASHRAE/ANSI 135-2012 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.
   6. ASHRAE/ANSI 135-2012 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

1.11 QUALITY ASSURANCE

A. BAS Manufacturer Qualifications
   1. The BAS manufacturer shall have an established business office within 100 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.
   2. The BAS Manufacturer shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BAS manufacturer shall be able to provide training certifications for all local office personnel upon request.
   3. The BAS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BAS manufacturer listed in this specification.

1.12 SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:
   1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 10 seconds of the operator's request.

2. Graphic Refresh. The system shall update all dynamic points with current data within 10 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 5 seconds. Analog objects shall start to adjust within 5 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 10 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.
9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.
   a) Table 1: Reporting Accuracy *(applicable to the project)*

Measured Variable	**Reported Accuracy**
Space Temperature	±1°F
Ducted Air	±2°F
Outside Air	±2°F
Water Temperature	±1°F
Delta –T	±0.25°F
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Air Flow (terminal)	±10% of reading
Air Flow (measuring stations)	±5% of reading
Air Pressure (ducts)	±0.1 "W.G.
Air Pressure (space)	±0.01 "W.G.
Water Pressure	±2% of full scale *Note 1
Electrical Power	5% of reading *Note 2
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

Note 1: for both absolute and differential pressure
Note 2: * not including utility supplied meters

1.13 WARRANTY REQUIREMENTS

A. Warranty all work as follows:
   1. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the

Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours.

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.
3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.
4. The BAS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

1.14 SYSTEM MAINTENANCE

A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).
   1. Make a minimum of 2 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:
      a) System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.
      b) Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and/or facility heating and cooling loads.
      c) Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.
      d) Database back-up
      e) Operator coaching
   2. Technician shall review critical alarm log and advise owner of additional services that may be required.
   3. Technician shall provide a written report to owner after each inspection.

B. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.

1.15 OWNERSHIP OF PROPRIETARY MATERIAL

A. Project specific software and documentation shall become the owner’s property upon project completion.

1.16 SEQUENCE OF OPERATION

A. Unit Shut Down
   1. All units connected to FACP shall be shut down in the event of fire. (By EC via fire alarm system).

2. All units with low limit controllers (freezestats) shall be shut down if supply air temperature drops below 35°F. Shut down includes closing OA dampers, shut down fan, open control valve (or face damper).
3. All low limit controls shall be hard wired to break fan controls. Wiring low limit through DDC is not permitted to break fan controls. Wiring from LC-1 to DDC system is for alarm purposes only.
4. When low limit control is activated, send auxiliary alarm signal to DDC unit controller. DDC system shall annunciate alarm condition.
5. **All temperature control valves and dampers will be spring return and shall fail to the "Safe" position for that system.**
6. **Bypass valve application will be size for 50% of the pump capacity of that system.**

B. Remote Monitoring:
1. Provide all software necessary to monitor all sensors, equipment status and alarm conditions at operate workstation and local second tier controllers.
2. Provide all software necessary to recognize, process and record alarm conditions as required by Owner.

C. Occupied/Unoccupied Cycle:
1. Each system with DDC controls shall function as an individual D/N zone with individual event times for start/stop.
2. Stagger initial start times to prevent simultaneous occupied cycle activation for all equipment.
3. In unoccupied cycle, when room sensor override button is pushed, start software timer (setpoint 2 hours) to provide Day (occupied) cycle for a software selectable period of time after which system reverts to Night (unoccupied) cycle.
4. While software timer is operating ignore additional override switch signals. System shall ignore switch signals initiated when area is in occupied cycle.

D. Morning Warm-Up: Provide software routine to initiate morning warm-up when outdoor conditions dictate, warm-up schedule shall be adaptive (i.e. optimize energy usage). During morning warm-up for classrooms and shop areas with motion detector, the detector is overridden until room occupied temperature setpoint is reached, duration (2) hours (adjustable).

E. Refer to drawings for unit specific sequences.

PART 2 – PRODUCTS

2.1 GENERAL DESCRIPTION

A. The Building Automation System (BAS) shall use us an open BACnet architecture and DDC controllers that are certified by BACnet Testing Laboratories (BTL) with the appropriate classifications. The BAS shall be capable to integrae to third-party devices and applications. The system shall be for use on the the Internet, or intranets using off the shelf, industry standard technology compatible with the owner provided network.

B. The Building Automation System (BAS) shall consist of the following:
   1. BACnet Testing Laboratories Certified Controllers
   2. Portable Operator Terminal(s)
   3. Networking processing, data storage, and communications equipment
   4. Other controls components required for a complete and working BAS

C. The Building Automation System (BAS) shall be modular in nature, and shall permit expansion of both capacity and functionality through addition of sensors, controllers, actuators, and operator devices, whilre reusing existing controls equipment.

2.2 BAS ARCHITECTURE

A. Communication Network
   1. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall be as defined below.
   2. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/Zigbee (802.15.4) as defined by the Zigbee Standard.
      a) Each communication interface shall be Zigbee Building Automation Certified product as defined by the BACnet Standard and the Zigbee Alliance.
      b) Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.
      c) Wireless equipment controllers and auxiliary control devices shall conform to:
         (1) IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
         (2) Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
         (3) Operating range shall be a minimum of 200 feet (60 m); open range shall be 2,500 ft. (762 m) with less than 2% packet error rate.
         (4) To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
         (5) Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
         (6) Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E.

3. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/MSTP (RS485) as defined by the BACnet standard.

B. Integrator Panel:
1. The BAS System shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS and the 3rd Party manufacturers' control panels. The BAS shall receive, react to, and return information from multiple building systems, including equipment manufacturers' integral packaged controls that do not have the BACnet protocol.
2. All data required by the application shall be mapped into the BAS database, and shall be transparent to the operator.
3. Point inputs and outputs from from the third-party controllers shall have real-time interoperability with the BAS such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, and Local Area Network Communications.

BACNET Protocol Integration:

4. The neutral protocol used between systems will be BACnet and must comply with the ASHRAE BACent standard 135.
5. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
6. The ability to command, share point object data, chance of state data, and schedules between the host and BACnet systems shall be provided.

C. The Controls Contractor shall provide all communication media, connectors, repeaters and network switches routers necessary for the high speed Ethernet communications network.

2.3 OPERATOR USER INTERFACE

A. Furnish 1 PC based operator interface as shown on the system drawings. Each operator web interface shall be able to access all information in the system. Operator interfaces shall reside on the same dedicated high-speed IP network as the System Controller(s).
1. Each operator interface PC shall include the following:
a) Hardware type
(1) PC or Laptop
b. Minimum Hardware
(1) Pentium Core 2 DUO or better
(2) 4 GB RAM
(3) 100 GB hard drive space
c. Internet Browser compatibility outlined in the following sections.

B. Operator web interface
1. The operator web interface shall be accessible via a web browser without requiring any "plug-ins" (i.e. JAVA Runtime Environment (JRE), Adobe Flash).
2. The operator web interface shall support the following Internet web browsers:
a) Internet Explorer 11.0+
b) Firefox 47.0+

c) Chrome 51.0+

3. System Security
   a) Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.
   b) User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
   c) Each operator shall be allowed to change their user password.
   d) The System Administrator shall be able to manage the security for all other users.
   e) The system shall include pre-defined "roles" that allow a system administrator to quickly assign permissions to a user.
   f) User logon/logoff attempts shall be recorded.
   g) The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
   h) All system security data shall be stored in an encrypted format.
   i) The system shall support Active Directory for user set-up and management.
   j) The system shall track and record all user log-in activity and all changes done at the enterprise level including who made the change, when, what was changed, pervious value and new value.
4. Database
   a) Database Save: A system operator with the proper password clearance shall be able to archive controller back-ups on the designated Enterprise operator web interface PC.
   b) Database Restore: The system operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
   c) Database Limits. The system operator shall have the ability to set limits on Alarm Log, Global Point Control Log, System Log, and User Change Log to manage database size.
5. On-line Help and Training
   a) Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.
   b) On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.
6. System Diagnostics
   a) The system shall automatically monitor the operation of all network connections, building management panels, and controllers
   b) The failure of any device shall be annunciated to the operators.
7. Customizable Navigation Tree
   a) The Enterprise operator web interface shall include a fully customizable navigation tree that shall allow an operator to do the following:
      (1) Move and edit any of the nodes of the tree.
      (2) Move entire groups to any area of the tree
      (3) Change the name of any node in the tree
      (4) Create custom nodes for any page in the web interface including graphics, data log views, schedules, and dashboards.
      (5) Support navigation from multi-building to single building view.
      (6) Provide the ability to assign graphics to any node in the tree.

(7) Ability to create folders and assign and change hierarchy of nodes of the tree.

8. Equipment & Application Pages
   a) The Enterprise operator web interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
      (1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System.
      (2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
      (3) Historical Data (As defined in Data Log section below) for the equipment or application without requiring a user to navigate to a Data Log page and perform a filter.
      (4) View of all custom graphical programming for supported controllers in real time.
      (5) View and management of all points for equipment and applications.
      (6) Support documents that have been assigned for that equipment.
      (7) Live data view for any selected points.
      (8) Touch friendly design for all action buttons, navigation, and spacing.
9. System Graphics. Enterprise operator web interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.
   a) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.
   b) Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
   c) Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.
   d) Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
   e) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
10. Custom Graphics
    a) The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.

b) Graphical Navigation. The Enterprise operator web interface shall provide dynamic color graphics of building areas, systems and equipment.

c) Graphical Data Visualization. The Enterprise operator web interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.

d) Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.

11. Graphics Library. Furnish a library of standard MECHANICAL equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.

12. Document Support. The Enterprise operator web interface shall support the ability to import support files into a support files library.

a) Imported support files can include the following types of document formats: pdf, docx, xlsx, pptx, jpeg, tif, bmp, png, jpg, gif.

b) All imported support files can be associated directly with equipment or family types that can then be accessed directly from standard pages.

13. Manual Control and Override

a) Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.

b) Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.

c) Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.

d) Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.

e) Global Point Control. Provide a method for a user to view, override, and edit if applicable, the status of multiple object and properties in the system. The point status shall be available by menu, on graphics or through custom programs.

14. Engineering Units

a) Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.

b) Unit selection shall be able to be customized by locality to select the desired units for each measurement.

15. Scheduling. A user shall be able to perform the following tasks utilizing the Enterprise operator web interface:

a) Create a new schedule, defining the default values, events and membership.

b) Create expectations to a schedule for any given day.

c) Apply an exception that spans a single day or multiple days.

d) View a schedule by day, week and month.

e) Exception schedules and holidays shall be shown clearly on the calendar.
f) Modify the schedule events, members and exceptions.
g) Create schedules and exceptions for multiple buildings.
h) Apply emergency schedule to multiple buildings
i) Drag and drop scheduling editing
j) Global schedule and exceptions across multiple buildings

16. Time of day scheduling
    a) Individual time schedules shall be provided for all areas and as listed below. The schedules for each area shall operate independently and shall be configured to meet the requirements of the Owner. The start time of each area shall be configured with optimum start times software functions, stop times shall follow a simple off time schedule.

Areas	**Approx. Occupied Time**
Office Areas	06:30 - 17:00
Classroom	07:00 - 15:00
Library	07:00 - 15:00
Toilet Room Exhaust Fans	06:00 - 20:00
Gymnasium	09:00 - 15:00
Auditorium	09:00 - 15:00
Kitchen	06:00 - 1500
Open Area	07:00 - 17:00

Note: General equipment associated with a particular area shall follow the area start/stop time schedule (i.e. – classroom general exhaust fans shall stop @ 15:00).

17. Data Logs
    a) Data Logs Definition
        (1) The Enterprise operator web interface shall allow a user with the appropriate security permissions to define a Data Log for any data in the system.
        (2) The Enterprise operator web interface shall allow a user to define any Data Log options as described in the Application and Control Software section.
        (3) Data Log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.
        (4) Each data point data line shall be displayed as a unique color.
        (5) Data points can be hidden on the display view by clicking on the point.
        (6) The operator shall be able to specify the duration of historical data to view by scrolling, zooming, or selecting from a pull down list.
        (7) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.
        (8) Operator will have the ability to show alarms and overrides on any data log view.

b) Export Data Logs
(1) The Enterprise operator web interface shall allow a user to export Data Log data in CSV, xlsx or text format for use by other industry standard word processing and spreadsheet packages.

C. Central Server – Components (Provide server as required)
1. The central physical or virtual server shall consist of the following (minimum):
2. System shall utilize a server class PC, tower or rack mounted.
3. Two 3.0 GHz, Quad Core
4. 8GB, DDR266 SDRAM memory
5. Hard Drive 73 GB
6. RAID 5 (recommended)
7. Microsoft Windows Server 2012/2014
8. Microsoft SQL Server 2008/2012
9. No Exception Taken Framework V3.5, 4.0
10. TCP/IP Interface

D. The central server shall provide the following applications within the system.
1. Trend Log Application
a) The system shall automatically harvest trend logs for defined key measurements for each controlled MECHANICAL device and MECHANICAL application.
b) The automatic trend logs shall monitor these parameters for a minimum of 30 days at 15 minute intervals. The automatic trend logs shall be user adjustable.
2. Site Management
a) The system must allow for grouping of the many sites in an enterprise in a logical manner.
b) The system shall provide a search function to allow users to search for sites or groups of sites by name or partial names.
c) The system must provide the necessary means to add, remove, and manage site.
3. Automatic System Database Save and Restore
a) The central server shall store on the hard disk backup tables of data including trends, alarms, custom settings and user profiles.
b) The data shall be backed up once a day.
c) This database shall be updated whenever a change is made in the system.
d) The storage of this data shall be automatic and not require operator intervention.
e) This capability is completed through SQL scheduled automated tasks for backup and only available in full SQL, and not SQL Express.
4. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database manually at any time.
5. System Configuration. The central server shall serve web pages as the interface for configuring the operator-level functions of the system. A user with proper security shall be able to configure the system to allow for future changes or additions.

E. Portable Operator's Terminal P.O.T (where indicated).: (Intended for portable field diagnostic tool.) Provide laptop computer with terminal emulation software to interface with DDC panels. Computer shall be Windows platform with latest stable windows operating system (Windows 8.1) integral pointing device. Furnish unit with all interface cards, cables, and software necessary to operate with DDC communications network, and to communicate directly with unit control panels. Furnish with (2) sets interface cables. Provide Windows 8.1 software. Schedule of laptop computer requirements:

Processing Chip	Pentium N3540, 2.5 GHz
RAM Memory	4 GB
Hard Drive	500 GB 5400 RPM
Two USB	USB 2.0 Ports and 3.0 Ports
Display	15" LED True Life HD
Video	HDMI Port
Sound	Maxx Audio
LAN Comm.	Ethernet Communications Board, 3COMM; or equal
Wireless Card	3-1 Memory Card Reader

F. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the building operator interface.

1. Scheduling. Provide the capability to schedule each object or group of objects in the system based off of the owner's request. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
    a) Weekly Schedule. Provide separate schedules for each day of the week.
    b) Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
    c) Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
    d) Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

2. Trend Log Application
   a) Trend log data shall be sampled and stored on the System Controller panel and shall capable of being archived to a BACnet Workstation for longer term storage.
   b) Trend logs shall include interval, start-time, and stop-time.
   c) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.
3. Trend Logs
   a) The system controller shall create trend logs for defined key performance indicators for each controlled MECHANICAL device and MECHANICAL application.
   b) The trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.
4. Alarm/Event Log
   a) Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.
   b) Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
   c) An alarm/event shall be capable of triggering any of the following actions:
      (1) Route the alarm/event to one or more alarm log
      (2) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
      (3) Route an e-mail message to an operator(s).
      (4) Log a data point(s) for a period of time.
      (5) Run a custom control program.
5. Point Control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.
6. Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, building operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the building operator interface.
7. Anti-Short Cycling. All binary output points shall be protected from short cycling.
8. Alarm/Event Notification:
   a) An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
   b) The operator will have the option of selecting an audible alarm notification for all alarm classes they subscribe to.
   c) The system operator will have the option of setting specific times and days that that they will receive alarm notifications.
   d) Provide software alarm points as listed below and as required by the Owner. Contractor shall meet with the Owner to include additional alarm point annunciation as requested by the Owner.

Point	Alarm Function
Hardware	Communication Failure Hardware Failure
Space Temperature	Out of Limits (± 5° from setpoint)
Duct Air Temperature	Out of Limits (± 10° from setpoint)
Water Flow Switch	Loss of Flow
Air Flow Switch	Loss of Flow
Water Temperature	Out of Limits (± 10° from setpoint)
Freeze Stat	Report Freeze Condition
Current Flow Switch	Loss of Current (Fan/Pump)

9. User Change Log. The operator shall be able to view all logged user changes in the system from any Enterprise operator web interface.
   a) An operator shall be able to group user changes by: date, affected, date & affected, user, date & user, transaction type, date & transaction type, or sort only.
   b) The operator will have the option of additional filtering capability of: date, transaction, type, user, affected, and details that can be used individually or in conjunction with other filters.

2.4 BUILDING CONTROLLERS

A. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section.
   1. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
   2. The controller shall provide a USB communications port for connection to a PC.
   3. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
   4. All System Controllers shall have a real time clock.
   5. Data shall be shared between networked System Controllers.
   6. The System Controller 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.
      c) Create a retrievable file of the state of all applicable memory locations at the time of the failure.
      d) Automatically reset the System Controller to return to a normal operating mode.

   7. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40° C to 50° C [-40° F to 122° F].
   8. Clock Synchronization:
      a) All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.

b) All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.
c) All System Controllers shall automatically adjust for daylight savings time if applicable.

9. Serviceability
   a) Provide diagnostic LEDs for power, communications, and processor.
   b) The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
   c) All wiring connections shall be made to field removable, modular terminal connectors.
   d) The System controller shall utilize standard DIN mounting methods for installation and replacement.
10. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.
11. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.
12. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

2.5 ADVANCED APPLICATION CONTROLLERS

A. Advance Application Controllers shall be used to control all equipment or applications of medium and high complexity, including but not limited to Air Handlers, Boiler Plants and Chiller Plants.

B. For Stand-Alone Operation of Advanced Application Controllers:
   1. Shall operate a schedule in a standalone application using a Real Time Clock with a 7 day power backup.
      a) The Controller shall have a built in schedule (assessable with or without a display).
      b) Support will be for at least 3 schedules with up to 10 events for each day of the week.
      c) Each of the 3 schedules can be Analog, Binary or Multi-State.
      d) The controller shall support a minimum of 25 exceptions each with up to 10 events.

C. For ease of troubleshooting, the Controller shall support data trend logging.
   1. 25,000 samples minimum
   2. Trends shall be capable of being collected at a minimum sample rate of once every second.
   3. Trends shall be capable of being scheduled or triggered.

D. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.

E. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
   1. Storage conditions:
      a) Temperature: -67°F to 203°F (-55°C to 95°C).
      b) Humidity: Between 5% to 100% RH (non-condensing).
   2. Operating conditions:
      a) Temperature: -40°F to 158°F (-40°C to 70°C)
      b) Humidity: Between 5% to 100% RH (non-condensing).
   3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
   4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° F to 158° F [-40° C to 70° C].

F. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements.
   1. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types: 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.
   2. Shall support flexibility in sensor type, the Controller shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.
   3. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.
   4. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.
   5. The controller shall support pulse accumulator for connecting devices like energy meters.
   6. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.
   7. Any unused I/O that is not needed for the functionality of the equipment shall be available to be used by custom programs on the Controller and by any other controller on the network.
   8. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.
   9. The Controller shall provide a dedicated static pressure input.

G. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:
   1. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
   2. Expansion I/O can be mounted up to 650 ft. (200m) from control.
   3. Expansion I/O can be added in as small as 4 point increments.
   4. To keep BACnet network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus.

H. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.
   1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
   2. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box.
   3. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller's zone sensor.
   4. For safety purposes, the controller shall be capable of being powered by a portable computer's USB port for the purposes of configuration, programming and testing programs so that this work can be accomplished with the power off to the associated equipment.
   5. The Controller software tool service port shall utilize standard off-the-shelf USB printer cable.
   6. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.
   7. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.
   8. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
   9. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.
   10. Controller data shall be maintained through a power failure.

I. Software Retention: All Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

J. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

K. Controller must meet the following Agency Compliance:
   1. UL916 PAZX, Open Energy Management Equipment
   2. UL94-5V, Flammability
   3. FCC Part 15, Subpart B, Class B Limit
   4. BACnet Testing Laboratory (BTL) Listed.

L. A Local Operator Touch Sensitive Display shall be provided for Central Plant and Air Handler Controllers at building locations where specified in the sequence of operations or point list.

2.6 APPLICATION-SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controllers which, through hardware or firmware design, control specified equipment. They are not user programmable, but are customized for operation within the confines of the equipment they are designed to serve.

1. Application Specific Controller are only allowed when both the following are met.
    a) The equipment is compressor based or boiler based.
    b) The controller is provided by the equipment manufacturer and warrantied as part of the equipment.

B. Zone Controllers are controllers that operate equipment that control the space temperature of single zone. Examples are controllers for VAV, Fan coil, Blower Coils, Unit Ventilators, Heat Pumps, and Water Source Heat Pumps.

1. Software
    a) To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
    b) Stand-Alone Operation: Each piece of equipment specified in section "A" shall be controlled by a single controller and provide stand-alone control in the event of communication failure. In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.
    c) For controlling ancillary devices and for flexibility to change the sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language.
2. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
    a) Storage: -55° to 203° F and 5 to 95% Rh, non-condensing.
    b) Operating: -40° to 158° F and 5 to 95% Rh, non-condensing.
    c) Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
    d) Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° to 158° F.
3. Input/Output:
    a) For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
    b) For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
    c) For flexibility in selection and replacement of binary devices, the controller shall support dry and wetted (24VAC) binary inputs.
    d) For flexibility in selection and replacement devices, the controller's shall have binary output which are able to drive at least 12VA each.

e) For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).

f) For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.

g) For future expansion and flexibility, the controller shall have either on board or through expansion, 20 hardware input/output points. Expansion points must communicate with the controller via an internal communications bus. Expansion points must be capable of being mounted up to 650ft. (200 m) from the controller. Expansion points that require the BACnet network for communication with the controller are not allowed.

4. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
   a) Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
   b) All binary output shall have LED's indicating the output state.
   c) All wiring connectors shall removable without the use of a tool.
   d) Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link and through the controller's zone sensor.
   e) For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
   f) Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.
   g) BACnet MAC Address shall be set using decimal (0-9) based rotary switches.
   h) Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
   i) BACnet trending objects resident on controller.
      (1) Minimum of 20,000 trending points total on controller
      (2) Shall be capable of trending all BACnet points used by controller
      (3) Shall be capable of 1 second sample rates on all points
5. Software Retention: All Zone Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
6. Transformer for the controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads, for a maximum of 12 VA for each binary output.
7. Agency Approval: The controller shall have meet the Agency Compliance:
   a) UL916 PAZX, Open Energy Management Equipment
   b) UL94-5V, Flammability
   c) FCC Part 15, Subpart B, Class B Limit

2.7 INPUT / OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through building, custom application, or ASCs.

B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V 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 to 10 VDC), current (4 to 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 custom application controllers shall have 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 10VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs shall not exhibit a drift of greater than 0.4% 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 operator tracking.

I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.8 POWER SUPPLIES

A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish overcurrent protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
   1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in overvoltage and overcurrent protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
      a. Line voltage units shall be UL recognized and CSA approved.

2.9 AUXILLARY CONTROL DEVICES

A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:
   1. (**D-1**): Opposed blade damper.
   2. (**D-2**): Parallel blade damper.
   3. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
   4. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
   5. Damper shaft bearings shall be as recommended by manufacturer for application.
   6. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.
   7. All leakage testing and pressure ratings will be based on AMCA Publication 500.
   8. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
   9. Control dampers shall be parallel or opposed blade types as scheduled on drawings.
   10. Acceptable Manufacturer shall be Ruskin, Greenheck, or equal.

B. Electric damper/valve actuators (**ME-1, ME-2, ME-3)**
   1. ME-1: Modulating range.
   2. ME-2: Two Position.
   3. ME-3: Modulating range, for unit ventilators.
   4. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
   5. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
   6. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
   7. Actuators shall be Underwriters Laboratories Standard 873 listed.
   8. Acceptable Manufacturer shall be Belimo or equal.

C. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
2. Size control valves according to chart below: (Maximum DP of 3 psi):

VALVE SIZE CHART

Max GPM	VALVE SIZE	CV
7.5	1/2"	4.4
13	3/4"	7.5
24	1"	14
35	1-1/4"	20
48	1-1/2"	28
69	2"	40
113	2-1/2"	65
156	3"	156
294	4"	294

3. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
   a) Water Valves:
      (1) Two-way: 150% of total system (pump) head.
      (2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
   b) Steam Valves: 150% of operating (inlet) pressure.
4. Water Valves
   a) Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
   b) Sizing Criteria.
      (1) (**CVT**) Two-position service.
      (2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 3 psi, whichever is greater.
      (3) (**CVM, CVZM**) Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 3 psi maximum.
      (4) Valves (1/2 in.) through (2 in.) shall be bronze body or cast brass ANSI Class 250, spring-return, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball, 23°F - 250°F.
      (5) Valves (2 1/2 in.) and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing, globe valve.
      (6) Never provide a controls valve that is less than half the size of the supply line serving that sytem.
   c) Terminal Unit Zone valves shall be sized to meet the control application and they shall be spring return so in the event of a power failure, they will go to full open.
5. Acceptable Manufacturer shall be Belimo; or equal.

D. Binary Temperature Devices (**THL-1)**

1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover. Acceptable Manufacturer shall be Honeywell; or equal.
2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover. Acceptable Manufacturer shall be Honeywell; or equal.

E. Temperature Sensors (**TSB, TSR, TSD, TSDA, TS/HS)**

1. TSB: Flat plate thermistor room sensor. ACI R2; or equal.
2. TSR: Room sensor with LCD display and setpoint adjustability. ZS Pro-M, Automated Logic; or equal.
3. TSD/TSDA: duct mounted sensor.
4. TS/HS: Combination temperature and humidity sensor. A/RH1; Automation Components, Inc.
5. Combination Temperature and Humidity sensor.
6. Temperature sensors shall be RTD or thermistor.
    a) Wireless space sensor component certifications shall include:
        (1) UL 916 - Energy Management Equipment.
        (2) UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances.
        (3) UL 873 - Temperature regulating and indicating equipment.
    b) The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.
7. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m2 (10 ft2) of duct cross section.
8. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
9. Space sensors shall be equipped with setpoint adjustment, override, display, and/or communication port as shown on plans.
10. Provide matched temperature sensors for differential temperature measurement.

F. Humidity Sensors (**HSTS-wall mount / HSP-duct mount**)

1. Space Humidity Sensors shall have a sensing range of 20% to 80% with accuracy of +/- 2% RH.
2. Duct Sensors and Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH with an accuracy of +/- 2% RH.
3. Humidity sensor's drift shall not exceed 1% of full scale per year.
4. Acceptable Manufacturer shall be Omega; or equal.

G. End Switch (ES-1)
   1. Proof of closure of damper. Kele; or equal.

H. Pressure Sensors (**DPT-1)**
   1. Air pressure of differential pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range. Acceptable Manufacturer shall be Setra; or equal.
   2. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range. Unit shall be provided with isolation and bypass manifold for startup and maintenance operations. Acceptable Manufacturer shall be Setra; or equal.

I. Low Limit Thermostats (**LC-1)**
   1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section. Acceptable Manufacturer shall be Honeywell; or equal.
   2. Low limit shall be manual reset only.

J. Carbon Dioxide Sensors (**CDS-1)**
   1. Carbon Dioxide sensors shall measure CO2 in PPM in a range of 50 ppm with drift not to exceed 20 ppm. Sensors shall be duct or space mounted as indicated in the sequence of operation.
   2. Acceptable Manufacturer shall be Dwyer; or equal.

K. Flow Switches (**FS-1)**
   1. Flow-proving switches shall be either paddle or differential pressure type.
   2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified. Manufacturer shall be Setra; or equal.
   3. 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 specified. Acceptable Manufacturer shall be Setra; or equal.

L. Air Flow Probes (**AF-1)**
   1. Provide an array of airflow traverse probes where indicated, capable of continuously monitoring the fan or duct capacities (CFM) they serve. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30°. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for MECHANICAL duct installation.

2. The airflow traverse probe shall not induce a pressure drop in excess of 0.03" w.c. at 2000 FPM, nor measurably contribute to sound levels within the duct. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.
3. Provide the minimum number of probes indicated: Duct height 8 – 12", 1 probe; 13 – 30", 2 probes; 31 – 54", 3 probes; 55 – 84", 4 probes; 85 – 120", 5 probes; 121 – 180", 6 probes.
4. The airflow traverse probe shall be the VOLU-probe as manufactured by Air Monitor Corporation, or equivalent.

M. Hydronic Flow Meters (**FM-3**)
1. Insertion-Type Turbine Meter
   a) Insertion type, complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.
   b) Liquide flow measurement devices shall be accurate to +/- 1% over a turn down ratio of 10:1.
   c) Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards.
   d) All wetted metal parts shall be constructed of 316 stainless steel.
   e) Analog outputs shall consist of non-interactive zero and span adjustments, a DC linearly of 0.1% of span, voltage output of 0–10 Vdc, and current output of 4–20 mA.
   f) Acceptable Manufacturer shall be Onicon; or equal.

N. Relays (**CR-1)**
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 solidstate plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.
3. Acceptable Manufacturer shall be Functional Device Inc;. or equal.

O. Transformers and Power Supplies
1. Control transformers (**XT-1**) shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
3. Unit shall be UL recognized.
4. Acceptable Manufacturer shall be Functional Device Inc.; or equal.

P. Current Switches (**CFS-1)**

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 DDC system.
2. Acceptable Manufacturer shall be Functional Device Inc.; or equal.

Q. Immersion Temperature Sensor (**ITS, ITS-1)**

1. Furnish with brass thermowell. Well insertion length to center of pipe. Glycol system require stainless steel well. ACI; or equal.

R. Motion Detector (**MDS-1**)

1. Ultra- sonic type omni directional transmitter, dual receivers, sensitivity gain control, 600 sq. ft. coverage, 24 Volt DC, Universal Energy Control Inc.; or approved equal.

S. Static Pressure Sensor (**SPS-1, SPNL-1)**

1. Model 264, pressure transmitter 4-20mA, 0-5VDC, 2.5VDC bidirectional output, 24VDC power by this Contractor, range 0-1.0" wg. or as applicable to individual systems needs. Setra; or approved equal.

T. Current transmitters

1. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and ±1% full-scale accuracy at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
3. Unit shall be split-core type for clamp-on installation on existing wiring.
4. Acceptable Manufacturer shall be Functional Device Inc. or equal.

U. Power Monitors

1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
2. 1.0% full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120–600V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0 - 0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/ shorting switch assembly is required.
6. Acceptable Manufacturer shall be Allen-Bradley; or equal.

V. Push Button (**PB-1)**

1. Flush mount, stainless steel plate, mushroom head, contact block with red nameplate, white lettering to identify fan and purpose.

W. Thermal Energy Meters
   1. Matched RTD or thermistor temperature sensors with a differential temperature accuracy of ±0.15°F.
   2. Flow meter that is accurate within ±1% at calibrated typical flow rate and does not exceed ±2% of actual reading over an extended 50:1 turndown range.
   3. Unit accuracy of ±1%
   4. NEMA 1 enclosure.
   5. UL listed.
   6. Isolated 4–20 ma signals for energy rate and supply and return temperatures and flow.
   7. Acceptable Manufacturer shall be Onicon; or equal.

X. Carbon Monoxide Sensor (**CDS-1**)
   1. Wall mounted Carbon Monoxide Sensor (CO) shall monitor CO over a range of 0-300 PPM.
   2. The device shall have an accuracy of +/- 3% and operate within the range of 32-110 deg F and 0-95% RH.
   3. Acceptable Manufacturer shall be Honeywell; or equal.

Y. Local Control Panels (**TCP, TCP-1)**
   1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
   2. Interconnections between internal and face-mounted devices shall be 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 over-current protection for control power sources to each local panel.

PART 3 – EXECUTION

3.1 EXAMINATION

A. The Contract Documents shall be thoroughly examined for coordination of control devices, their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The BAS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.2 PROTECTION

A. The BAS installation contractor shall protect all work and material from damage by their work or personnel, and shall be liable for all damage thus caused.

B. The BAS manufacturer shall be responsible for their work and equipment until final inspection, testing, and acceptance. The BAS installing contractor shall protect their work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

A. Site
   1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
   2. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals. Refer to the "Submittals," section of this specification for requirements.

C. Test and Balance
   1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
   2. The contractor shall provide training in the use of these tools. This training will be planned for a duration of 4 hours.
   3. The tools used during the test and balance process shall be returned to the contractor at the completion of the testing and balancing.

D. Life Safety
   1. Duct smoke detectors required for air handler shutdown shall be supplied under Divison 26 contract. The contractor shall interlock smoke detectors to air handlers for shutdown as described in the Sequences of Operation for this project.

E. 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 by the contractor as follows:
   1. All communication media and equipment shall be provided as specified in the "Communication" section of this specification.
   2. Each supplier of a 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. The Contractor shall 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.

F. Fire Alarm: Provide interface card to allow communications between temperature control network and fire alarm system. Coordinate exact requirements with Electrical Contractor. Provide all hardware and software necessary for full seamless interface. Show fire alarm failure on graphics.

3.4 GENERAL WORKMANSHIP

A. Install equipment, piping, wiring/conduit, parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible locations as defined by National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures.

E. All control device installation and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents.

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 Contract Documents.

B. BAS manufacturer shall continually monitor the field installation for building code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. BAS installing Contractor(s) shall arrange for field inspections by local and/or state authorities having jurisdiction over the wor.

3.6 WIRING

A. All control and interlock wiring shall comply with the National, Local Electrical Codes, and Divison 26 of these Contract Document specifications.

B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC requirements.

C. All wiring in plenum spaces shall be enclosed in conduit. Plenum rated cable can be used in accessible ceilings.

D. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that the following conditions are met:
   1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
   2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose).
   3. Line Voltage Control Wiring:
      a) For control relays or other low amperage circuits #14 AWG THHN.
      b) For direct line voltage control of equipment minimum conductor size #12 AWG THHN.
      c) Electronic Sensor Wiring: 18 AWG, stranded (16x30) copper conductors, twisted pair, 100% overall aluminum polyester shield, 20 AWG CU drain wire. Polyethylene insulation, PVC jacket, 300V, 60°C. Furnish Belden; or equal.
      d) Computer Communications Cable: 18 AWG, stranded (16x30) copper conductors, (2) twisted pair, 100% individual aluminum polyester shields each shield with 20 AWG CU drain wire. PVC insulated, PVC jacket, 300V. Furnish Belden; or equal. Note: Actual # of conductors may be increased as required for actual communication requirement.
   4. Provide minimum (1) spare shielded twisted pair conductors in each communications wiring run. Wiring runs between operator work stations (if any) provide (2) spare shielded twisted pair conductors.

E. Do not install Class 2 wiring in conduits 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 via control relays and transformers.

F. Where Class 2 wiring is run exposed, wiring shall be conduit

G. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the BAS manufacturer shall provide step-down transformers to achieve the desired control voltages.

H. All control wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

I. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.

J. Conduit and wire sizing shall be determined by the BAS manufacturer in order to maintain manufacturer's recommendation and meet National and Local Codes.

K. Conduit Routing and termination
   1. Conduits shall be installed so as to be concealed in all finished spaces at the conclusion of the project unless otherwise noted. Conduits may be exposed in mechanical and electrical rooms and unfinished storage, maintenance and production areas.

2. Where it is impractical to conceal wiring or conduit in finished construction, cables shall be run in wiremold.
3. Make neat runs parallel or perpendicular to structural elements (walls, ceilings, floors) of building with minimum number of couplings and bends. Install so that required conductors may be drawn without injury or excessive strain.
4. Provide double locknuts and insulation bushings on the end of each conduit entering an enclosure. If smaller holes are used in knockouts provide listed devices which overlap largest knockouts as required to strengthen the termination.
5. Cap or plug open ends of conduits during construction.
6. Conduits shall be continuous from equipment controls to cabinets, junction or pull boxes and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous.
7. Change in Direction of Conduit:
   a) Concealed locations - use standard radius bend.
   b) Exposed locations or concealed locations where conduit will be accessible; use standard radius bends or conduit body.
8. Install conduits to allow proper drainage. Do not form pockets.
9. Securely attach all conduits to building structure utilizing approved methods and fastening devices for support.
10. Clear obstructions in raceways or replace raceways at no additional contract cost. Demonstrate to Architect that spare conduits are free of obstruction at substantial completion and leave a drag line (1/8" polypropylene monofilament utility rope) for future use.

L. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring.

M. Adhere to the Division 26 requirements for installation of electrical raceways.

N. BAS manufacturer shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

O. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

P. Penetrations:
1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways. All other project fire stopping to be by other trade.
2. All openings in the fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls, shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true and square.
5. No penetrations in structural elements shall be made before receipt of written approval from Engineer and/or Architect.

Q. BMS Raceway:

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 3/4".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (wiremold) may be used as approved by the Engineer.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible metal conduit shall be used for vibration isolation and shall be limited to 3' in length when terminating to vibrating equipment. Flexible metal conduit may be used within partition walls. Flexible metal conduit shall be UL listed.

3.7 COMMUNICATION WIRING

A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

B. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer shall not be exceeded during installation.

D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

E. When a cable enters or exits a building, a lighting arrestor must be installed between the line and ground.

F. All runs of communication wiring shall be unspliced length when the length is commercially available.

G. All communication wiring shall be labeled to indicate origin and destination.

3.8 FIBER OPTIC CABLE

A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacturer's specifications.

C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

3.9 INSTALLATION OF SENSORS

A. Sensors required for mechanical equipment operation shall be factory installed and wired as specified in mechanical equipment specifications. BAS manufacturer shall be responsible for coordinating these control devices and ensuring the sequence of operations will be met. Installation and wiring shall be in accordance with the BAS manufacturer's recommendations.

B. Sensors that require field mounting shall meet the BAS manufacturer's recommendations and be coordinated with the mechanical equipment they will be associated.

C. Mount sensors rigidly and adequately for the environment the sensor will operate.

D. Room temperature sensors shall be installed on concealed junction boxes properly supported by the block wall framing. For installation in dry wall ceilings, the low voltage sensor wiring can be installed exposed and must meet applicable National and Local Electrical Codes.

E. All wires attached to wall mounted sensors shall be sealed off to prevent air from transmitting in the associated conduit and affecting the room sensor readings.

F. Install duct static pressure tap with tube end facing directly down-stream of air flow.

G. Install space static pressure sensor with static sensing probe applicable for space installation where applicable.

H. 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 horizontally across duct. Each bend shall be supported with a capillary clip.

I. All pipe mounted temperature sensors shall be installed in matched thermowells. Install all liquid temperature sensors with heat conducting fluid in thermal wells for adequate thermal conductance.

J. Wiring for space sensors shall be concealed in building drywall. EMT conduit is acceptable within mechanical equipment and service rooms.

K. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer's recommended location and coordinated with Engineer.

3.10 IDENTIFICATION OF HARDWARE AND WIRING

A. All field wiring and cabling, including that within factory mounted, and wired control panels and devices for mechanical equipment, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes. BAS manufacturer to coordinate this labeling requirement with mechanical equipment manufacturer as it relates to controls.

B. Permanently label or code each point of field terminal strips to show the instrument or item served and correlate them to the BAS design drawings.

C. Identify control panels with plastic nameplates.

3.11 GROUNDING AND BONDING

A. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated.
   1. Install green, equipment grounding conductor with all feeder and branch circuit conductors.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
   3. Enclosures: Ground all enclosures of electrical and electronic wiring and distribution equipment in accordance with requirements of the NEC Article 250.
   4. Equipment Enclosure Grounding: Bare wire, wrapped around connecting screws or mounting bolts and screws is not acceptable as a grounding connection. All ground lugs shall be of a noncorrosive material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. In general use tinned copper connectors for connections of dissimilar metals. Use of bimetal connectors shall only be allowed in special circumstances and only with the prior written approval.

3.12 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

C. Raceway Grounding: Surface metal raceways, wireways, or cable trays or cable rack systems shall be installed in a manner that ensures electrical continuity. Short insulated green copper bonding jumpers shall be installed between adjacent raceway sections, on both sides of each joint, to ensure proper bonding. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Jumpers shall be provided with compression connectors at each end of cable. Surface metal raceways, wireways, cable trays or cable rack systems shall be field drilled to provide bolting point for securing bonding jumper. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. Bolts and hardware shall be as per details or as approved for grounding purposes. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.

D. Other Grounding Systems: Any additional grounding systems used for electronic equipment shall be connected to the facility main ground plate, structural steel or exterior earth electrode system as shown on drawings.

E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.

3.13 CONTROL SYSTEM CHECKOUT AND TESTING

A. Acceptance Check Sheet:
   1. The contractor shall prepare check commissioning sheets that include all points for all functions of each system as indicated on the temperature controls submittal documents.
   2. Submit the check sheets to the engineer for approval within the temperature controls submittal documents.
   3. Engineer will use the approved check sheets as the basis for acceptance of the BAS.
   4. The contractor is perform complete commissioning reports for this project. Prior to final payment, contractor must submit signed commissioning checklist, approved by both the owner and engineer. The contractor must also prepare commissioning reports for each piece of equipment that is being controlled.

B. Start-up testing. All testing in this section shall be performed by the contractor and 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. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all of the instruments, controls, and accessory equipment furnished under this specification.
   2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
   3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer's recommendations.
   4. Verify all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starter, etc.) operate properly and normal positions are correct.

5. Verify all analog output devices (I/Ps, actuators, etc) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify 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 optimal start/stop routines.
7. 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.

C. Start-up testing. All testing in this section shall be performed by the contractor and 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.

3.14 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Acceptance: The BAS will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. 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 Owner's representative. Such tests shall then be performed as part of the warranty.

3.15 TRAINING

A. Provide minimum of 2 classroom training sessions, and 4 hours for each session, throughout the contract period. The training will be provided for personnel designated by the Owner.

B. Provide course outline and materials prior to schedule training session. The instructor(s) shall provide one copy of training material per student.

C. The instructor(s) shall be factory-trained and experienced in teaching this technical material.

END OF SECTION

SECTION 23 21 00

WATER SYSTEM SPECIALTIES AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of all materials used.
B. Product data for all specialties.

1.3 GENERAL REQUIREMENTS

A. All equipment and accessories in this section shall be rated for a least 125 psi wwp, and 250°F minimum temperatures, unless otherwise specified.
B. Manufacturer's written installation procedures shall become a part of these specifications.
C. All terminal water system specialties and equipment shall be line size.

PART 2 - PRODUCTS

2.1 WATER SYSTEM SPECIALTIES AND EQUIPMENT

A. ADS-X: Air eliminators / separators shall be a combination full flow coalescing type high efficiency air eliminator / dirt and sediment separator, fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM. Designated models specifically designed for high velocity systems may have an entering velocity of up to 10 feet per second and shall meet ASME construction. Vessel diameter shall be a minimum of two times pipe size. Vessel height above the nozzle center-line shall be a minimum of 3 times pipe size for standard units and 4.5 times pipe size for high velocity units. Vessel shall extend below nozzle center-line the same distance for dirt separation. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium is to be wound completely around and permanently affixed to each internal element. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Unit shall include a blow down valve at bottom for removal of collected dirt and sediment. Air eliminator function shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid during continuous circulation. Dirt and sediment separator function shall be capable of removing 80% of particles 30 micron and larger

within 100 passes. A properly selected strainer (see strainer specification) shall be installed upstream to collect large debris that may be left in the piping. Units shall be Spirovent® model VDT for standard velocity or model VHT for high velocity systems or equal in size and construction.

B. AF-1: High capacity air vent; float actuated non-modulating. Positive shut off up to 150 psig and a maximum temp. of 250°F. Cast Iron construction with internal components of Type 313 stainless steel, brass, Buna-N and silicone rubber. Bell & Gossett, Model #107; or equal.

C. AS-X: Air separator, flanged connections unit must be constructed in accordance with ASME boiler and pressure vessel code, and stamped 150 psig working pressure at 350°F. (Contractor shall provide threaded flanges for air separator where required.) Unit to be constructed in accordance with ASME pressure vessel code and stamped 125 psi working pressure

D. AV-1: Air bleed valve, at each high point or air pocket in water piping systems, 1/8" NPT size, brass body, key operated, extension tube if required. 150 working pressure and 225°F operating temperature. Bell & Gossett Model #4V; or equal.

E. AV-2: Air eliminator 3/4" inlet, normally open, float actuated valve. Cast iron construction with stainless steel float, valve head and float. Provide 3/8" relief tube to 6" AFF. Model #13 W; Spirax Sarco, Inc.; or equal.

F. BFP-1: Backflow preventer, minimum size = 1", 3/4" NPT connections, bronze body construction with Celcon check seats. Provide bronze strainer and full port bronze ball valves. Watts Regulator Co., Model #909 SQT; or equal.

G. CFP-1: Chemical feed pot, 5 gallon size, steel tank and head, iron cap with gasket. Unit shall have four connections for flow, vent, and drain. Provide with leg extensions for floor mounting. Unit shall be constructed in accordance with ASME pressure vessel code. Griswold Water Systems Model #DB-5-GE-CS-A-250; or an approved equal.

H. ET-X: Pre-charged steel expansion tank with replaceable heavy duty butyl rubber bladder. Tank must be constructed in accordance with the ASME Boiler & Pressure Vessel Code and stamped for 125 psi working pressure. Tank shall have drain and charging valve connection to facilitate on-site charging to meet system requirements. Tank to be fitted with removable access hatch, lifting rings, and floor mounting skirt for vertical installation. Unit to be constructed in accordance with ASME pressure vessel code and stamped 125 psi working pressure

I. EXP-1: Flexible expansion loops consisting of (3) flexible sections of stainless steel and braided hose with flanged ends. Loops to be rated for 250 psgi at 400 deg F. Loops to provide +4" movement. Loop shall impart in neutral condition. Install per manufacturer's recommendations. Provide nested loops as required. Provide size to match pipe size; Triflex Loop by Flex-Hose with stainless steel braid, c/s 150#RFSOF flanges.

1. Guides: Provide pipe guides on both sides of loop, with guides insulated as per section 230719. Attach guides to pipe, and secure guides to building structure. Guides to be steel, factory-fabricated alignment guide, with bolted two-section

outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Contractor to provide supplemental steel as required to install guides. Install one guide on each side of pipe expansion loop. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

2. Anchors: Provide anchors a maximum of 10ft from ends of straight section of pipe that contains expansion loop. Anchors to resist 250 ft/lb. of force. If contractor substitutes on another type of expansion loop (i.e.. 'V' loop), contractor shall be responsible for calculating anchor loads and be fully responsible for providing the correct anchors and supporting steel to fully handle forces imparted on anchor.

J. IJ-1: Isolation joint flexible connector, size as required, stainless steel construction, single braided, flanged connections. Model #PCS, Flexonics Inc.; or an approved equal. Contractor to provide threaded flanges for isolation joints 2" and smaller.

K. PG-1: Pressure gauge, 0-60 psig range 4-1/2" dial, bottom connection, cast aluminum case, slip ring, phosphor bronze bourdon tube, brass socket, bronze rotary movement, 1% accuracy. Albert A. Weiss & Sons, Inc., Cat. #4PGAN-1; or equal. Pressure gauge shall be installed with shut-off valve pressure pulsation snubber.

L. PRV-1: Pressure reducing valve minimum size = 1", 3/4" set at 20 psig screwed connections. Watts regulator Model #223LP: or equal.

M. PSD-1: Angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, flow straightening vanes, start-up strainer, permanent magnet and adjustable support foot. All internal components shall be replaceable. Armstrong Model #SG43; or equal. Coordinate pump and system connection sizes with drawings.

N. RV-1: Relief valve, water service, refer to drawing for pressure setting, size per capacity of system, minimum 1" size, bronze body and bonnet, brass trim. Furnish Bell and Gossett Model # 1170; or an approved equal.

O. SS-1: Pipeline strainer, line size up to 2", screwed cast bronze body, 20 mesh stainless steel screen, for liquid or steam service. S.W.P. 125 lbs at 400°F. Series #777S, Watts Regulator Co.; or equal. Note: Provide ball valve BV-1 and hose connections for blow-down.

P. SS-2: Pipeline strainer, line size 2-1/2" and up, flanged connections, cast iron body, 20 mesh stainless steel screen, W.P. 125 lbs, for liquid or steam service. Series 77-125, Watts Regulator Co.; or equal. Note: Provide ball valve BV-1 and hose connections for blow down.

Q. TDV-1: Provide valve to perform functions of a non-slam check valve, throttling valve, shutoff valve and calibrated balancing valve. Note: the submitted pressure drop shall not exceed 2ft. The TAB contractor shall balance to 3ft. Cast iron construction with 125 psi ANSI flanged connections suitable for 375 psi maximum working pressure and 230°F operating temperatures. Valve body shall be ductile iron with grooved ends and anti-rotation lugs. Body shall have (4) 1/4" connections. (2) shall have brass pressure and temperature metering ports with check valves and caps. The (2) other connections shall have drain plugs. Metering ports are to be interchangeable with drain ports. Valve disc shall be bronze plug disc type with high impact engineered resin seat. Valve stem shall be stainless steel. Provide with flange adapters with anti-rotation lugs and EPT gaskets. Armstrong, Model #FTV, Flow-trex combination valve; or approved equal.

R. TH-1: Thermometer, cast aluminum case and adjustable joint, copper plated steel bulb chambers, separable brass socket, range 30°F to 240°F. Weiss Instruments, Inc. Vari-angle, Model #9VS6; or equal.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All equipment and systems as shown on the drawings or specified herein shall be installed in accordance with the provisions of each applicable section of these specifications.

B. Provide 4" high concrete housekeeping pads where required.

C. Obtain detailed written or graphical instruction from each manufacturer for proper method of installing each piece of equipment.

D. Provide reducers where required to adapt water system specialties to piping system.

E. Provide all supporting steelwork, hangers, and suspension racks as required, and support as approved by Architects.

3.2 SYSTEM FILLING

A. After cleaning, fill each system from low point:
   1. With pumps off, vent all mains, risers, runouts, units, etc., working consecutively from low to high point in building. Obtain approximately 2 psi at highest point. Obtain proper air cushion in compression tanks. Vent all released air and gases at all vent points. Check high level in compression tanks; drain if necessary.

3.3 AIR VENTING

A. Provide vents at all points in piping system where air may collect. Provide one of the following:
   1. Manual vent assembly consisting of: 1-1/4" x 6" air collection chamber, 1/4" brass globe valve in accessible location, install hose connection to valve outlet.
   2. Automatic vent with air chamber.

3.4 EQUIPMENT VENTS

A. When Equipment is Above Mains: Connect runouts or risers to upper quadrant or top of mains. Install vent assembly concealed within enclosure, consisting of 1" diameter by 4" to 6" long air collection chamber with 1/4" soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units, provide screwdriver.

B. When Equipment is Below Mains: Connect piping runouts or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit, if required. Use tees instead of elbows at low point of runouts.

3.5 STRAINERS

A. Provide approved valved dirt blow-off connection for strainers, size 6" and larger. Equip with quick opening gate valve and brass plug. Valve located 6" to 12" below strainer or as approved, full size of tapping. Provide discharge piping if required for protection, when directed by Architects or shown on plans.
   1. Note: strainer to be mounted horizontally.

END OF SECTION

SECTION 23 21 13

PIPING SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of pipe and fittings.
B. Product data for all materials.
C. Test reports.

1.3 REFERENCE STANDARDS AND CODES

A. All installations and materials shall conform to applicable 2016 New York State Building code, and local building and plumbing codes.

B. All piping shall be inspected and approved by Underwriters Laboratories and bear the UL label.

C. All installations shall conform to requirements of Owner's Insurance carriers.

D. Refer to the latest edition and applicable sections of the following:
1. American Society of Testing and Materials (ASTM)
2. American National Standards Institute (ANSI)
3. American Society of Mechanical Engineering (ASME)
4. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
5. Boiler and Pressure Vessel Code, Section VIII, Division 1 - Pressure.
6. Boiler and Pressure Vessel Code, Section IV, Heating Boilers.
7. Code for Pressure Piping B31.9 - Building Services Piping.
8. American Welding Society (AWS).
9. National Fire Protection Association (NFPA)
10. National Electrical Manufacturer's Association (NEMA)
11. "Maximum allowable natural gas pressure: gas pressures within boiler rooms shall not exceed a maximum of 2 psig; gas pressures within buildings (other than boiler rooms) shall not exceed a maximum of 0.5 psig."

1.4 GENERAL REQUIREMENTS

A. All materials furnished and all installations made under this specification shall conform with the applicable requirements of the codes and standards described herein.

B. Layout of equipment, piping, etc. is diagrammatic, unless detailed. Check project drawings prior to making installations for interference's with other trades and services. Owner reserves the right to make reasonable changes prior to "rough-in" without added expense. All dimensions shown are subject to verification of exact site conditions.

C. Have any required local or municipal inspection processed and present to Owner with certificate indicating approval of such governing body.

D. Furnish and install all brackets, anchors, sleeves, seals and/or supports as required for the MECHANICAL installations. Where detail is not shown, submit shop drawings of intended construction for approval.

E. All work to be performed in cooperation with the Owner. Coordinate construction schedule with the Owner. Report delays in material receipt immediately to Owner indicating full circumstances concerning delay.

F. Piping systems shall be presented to the Owner complete, in perfect working order, tested in full accordance with the Contract Documents. All work associated with the installations shall be guaranteed in complete accordance with the Contract Documents.

G. Perform all testing as required and as specified herein.

PART 2 - PRODUCTS

2.1 PIPE

A. Heating Hot Water (2" & Below):
1. Type L, seamless hard drawn temper copper tube, ASTM B-88; wrought copper socket fittings, unions, ANSI B16.22; threaded valve connections, solder joints shall be 95-5 tin to antimony solder, conforming to ASTM B-32.
2. Type L, seamless hard drawn temper copper tube, ASTM B-88; unions, ANSI B16.22. For use with mechanically joined fittings.

B. Heating Hot Water (2-1/2" & Larger):
1. Black steel pipe, seamless or ERW, Schedule 40 with beveled ends, ASTM A-53, GR.B; steel weld joints and fittings, ASTM A-234; standard weight steel flanged connections to valves and equipment, butt-weld ends, raised facings, 150 lb. rating, ANSI B16.5.
2. Black steel pipe, seamless or ERW, Schedule 40 with beveled ends, ASTM A-53, GR.B; ASTM A-234; standard weight steel flanged connections to valves and equipment, 150 lb. rating, ANSI B16.5. For use with mechanically joined fittings.

C. Condensate Drain (1" & Below): Type M, hard drawn copper tube, ASTM B-88; wrought copper socket fittings, unions, ANSI B16.22; solder joints shall be 50/50 tin to lead solder, conforming to ASTM B-32.

D. Condensate Drain (1-1/4" & Larger): Type DWV, hard drawn copper tube, ASTM B-88; wrought copper socket fittings, unions, ANSI B16.22; solder joints shall be 50/50 tin to lead solder, conforming to ASTM B-32.

E. Cold Water Make-Up (All Sizes): Type L, seamless hard drawn temper copper tube, ASTM B-88; wrought copper socket fittings, unions, ANSI B16.22; threaded valve connections, solder joints shall be 95/5 tin to antimony solder conforming to ASTM B-32.

2.2 FITTINGS

A. 2" and Smaller – Copper Pipe Mechanically Joined Fittings:
1. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117. Sealing elements shall be factory installed EPDM. Fittings shall be rated for an operating pressure of 200PSI and operating temperature range of 0°F to 250°F
2. Manufacturer shall warranty fittings to be free from failure caused by manufacturing defect for a period of 50 years from date of installation.
3. Fittings shall not be allowed for use in below grade/direct buried application, or exposed outside of building envelope.
4. Fittings shall be Viega ProPress or equal

B. 2-1/2" and Larger - Steel Pipe Mechanically Joined Fittings:
1. Couplings shall be manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi.
a) Rigid Type: Victaulic Style 107H / W07. Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Above 12in, coupling keys shall be wedge shaped for increased strength. Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30°F to +250°F.
b) Flexible Type: Victaulic 177N / W77. Use in locations where vibration attenuation and thermal expansion compensation (including risers). Flexible couplings may be used in lieu of flexible connectors at equipment connections. Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30°F to +250°F.
c) Fittings: Cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, provided with an alkyd enamel finish. Factory-fabricated grooved end header all-in-one assembly for fluid distribution, consisting of an ASTM A53, Grade B, standard weight pipe spool with required outlet connections. Grooved ends roll grooved to Victaulic dimensions, with enamel coating.

2.3 IDENTIFICATION

A. Pipe Identification Markers: Furnish and install pipe identification markers on all piping installed under this contract. It shall consist of self-adhesive labels of black letters imprinted on color coded backgrounds indicating pipe fill and direction of flow. Lettering shall be 2" high on pipes 3" diameter and over and 3/4" high on pipes under 3". Markers shall be applied to pipe, or to insulation in case of insulated pipes, on 15' centers and at each valve, whichever is closer. Color code as follows:

	Legend	Background
a)	Heating Hot Water	Yellow
b)	Condensate Drain	Green
c)	Cold Water Make-Up	Green
d)	Refrigeration Piping	Green

B. All pipe identification colors shall conform to ANSI Standard A-13.1. Pipe identification markers shall be vinyl cloth, 0.0085" thick, Seton Nameplate Corp., Setmark Type; or equal.

C. Nameplates: Identify each valve, control entity or piece of equipment with stamped brass or engraved plastic nameplate permanently attached by riveting, wiring, etc. Set up complete identification system in cooperation with Owner's Physical Plant/Maintenance Department. Each drain plug or valve shall be tagged "DRAIN". Furnish and install engraved rigid laminated plastic nameplate to identify function of each control item on temperature control panel. Remote operating control switches shall have engraved faceplates to indicate function and/or operation controlled. Embossed and/or pressure sensitive plastic tape labels shall not be acceptable. Furnish engraved 2" x 1" black rigid laminated plastic nameplate for each motor starter furnished for mechanical equipment and present with motor starter to EC for mounting.

2.4 PIPING HANGER SYSTEMS

A. Heating System Pipe Hangers: Furnish cast iron single pipe roll hangers, carbon steel clevis hangers, carbon steel copper plated hanger, as required for proper installation. Furnish C Type beam clamps, carbon steel electro-galvanized continuous threaded rod and accessories as required. Furnish as manufactured by Elcen Metal Products Co., Michigan Hanger Co., Inc.; or an approved equal.

B. Non-Insulated System Pipe Hangers: Furnish clevis ring pipe hanger, carbon steel electro-galvanized finish, Model #401. Furnish steel c-clamps, continuous threaded rod and accessories.

C. Furnish trapeze hanger system in addition or in place of hanger systems above as detailed on drawings.

2.5 TEE CONNECTIONS

A. Two sizes or more smaller than main run in steel pipe, make with Bonney Forge, Inc., Weldolets or Threadolets; or equal. Copper tube run-out piping thus connected to steel mains shall be by means of bronze threaded adapter threaded into Threadolet.

2.6 LIABILITY

A. Contractor shall be held liable throughout guarantee period for any damage from failure of piping due to poor or faulty workmanship and/or defective materials.

2.7 STEEL PIPE HANGERS

A. Horizontal runs of pipe shall be securely held in place by means of suitable hangers. In general, hanger shall be clevis type with threaded rod supports. Chain or cold rolled flat steel straps are not acceptable. Supports shall be spaced according to the following schedule:

	Pipe Size	Maximum Spacing	Minimum Rod Size
1.	3/4 in.	5 ft.	3/8"
2.	1 in.	6 ft.	3/8"
3.	1-1/4 in.	6 ft.	3/8"
4.	1-1/2 in.	8 ft.	3/8"
5.	2 in.	10 ft.	3/8"
6.	2-1/2 in.	11 ft.	1/2"
7.	3 in.	12 ft.	1/2"
8.	4 in.	12 ft.	5/8"
9.	6 in.	10 ft.	3/4"
10.	8 in. and larger	10 ft.	3/4"

B. Heating piping hangers shall be applied directly to piping. Cut-out insulation for hanger and cover with jacketing. Insulation shall be "butt-up" to hanger as tightly as possible.

C. Where Piping is Supported From Open Web Steel Joists, and Running Perpendicular to the Joists:

1. Reduce the maximum hanger spacing for 8" pipe from 12 feet to 8 feet. Where two 6" or 8" pipes are running side by side, stagger the hangers so only the load from one pipe is applied to a joist. Where two 6" and two 8" pipes are running side by side, reduce the maximum hanger spacing for 6" pipe from 12 feet to 8 feet and for 8" pipe from 12 feet to 6 feet, and stagger the hangers so that no more than one 6" pipe and one 8" pipe are supported from a single joist. Where possible, support from steel beams or girders.

D. Where Piping is Supported From Open Web Steel Joists, and Running Parallel to the Joists:

1. Reduce the maximum hanger spacing for 6" pipe from 12 feet to 10 feet and for 8" pipe from 12 feet to 8 feet. Where two 6" or 8" pipes are running side by side, stagger the hangers so only the load from one pipe is applied to each support location. Where two 6" and two 8" pipes are running side by side or where four 6" inch pipes are running side by side, reduce the maximum hanger spacing for 6" pipe from 12 feet to 8 feet and for 8" pipe from 12 feet to 6 feet, span unistrut supports between at least three joists, and stagger the hangers so that no more than two pipes are supported at each support point. Where possible, support from steel beams or girders.

2.8 COPPER TUBE HANGERS

A. Pipe hangers for copper tube shall be copper plated hanger rings.

2.9 SLEEVES

A. Pipes passing through masonry construction shall be fitted with sleeves. Each horizontal sleeve shall extend through its respective wall and be flush with each surface. Each vertical sleeve shall extend through its respective floor slab, be flush with underside of slab, and extend 1/2" above top of finished slab. Sleeves shall be two pipe sizes larger than uninsulated lines and one pipe size larger than overall diameter of insulated lines.

B. See Section 230005 - MECHANICAL Work General; for penetration requirements through fire rated partitions, walls, floors etc.

2.10 PIPE ENCLOSURES

A. 16 GA metal piping enclosures by Sterling. Provide mounting strip and angle supports. Refer to drawings for three sided vertical (model #PCV) two sided vertical (model #PCV) or horizontal (model #PCH) enclosures. Color selection by architect.

VERTICAL PIPE ENCLOSURE			
PIPE SIZE (IN)	NUMBER OF PIPES	INSULATION THICKNESS	PIPE ENCLOSURE SIZE (IN)
3/4	2	1-1/2	10x5
1	2	1-1/2	10x5
1-1/4	2	1-1/2	10x5
1-1/2	2	2	12x6
2	2	2	14x8
2-1/2	2	2	16x8
3	2	2	16x10
4	2	2	18x10
6	2	2	20x12

2.11 FIN ENCLOSURE

A. For all exposed horizontal piping on a wall that is below 4ft, provide Sterling PCH-17 horizontal pipe enclosure, no louvers, flat top. Enclosure to be 18 CRS, 17" in height. Color selection by Architect.

PART 3 - EXECUTION

3.1 GENERAL PIPE INSTALLATION

A. The following shall describe methods of assembly to be followed in the installations of piping by the Contractor:
   1. All pipe shall be clean and free of internal mill scale, dirt, etc. before installation.

2. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing except where specifically called for. All pipe shall be out of the way of all windows, doors and other building openings or structural parts. All pipe shall be so installed that it can expand and contract freely without damage to any other portions of the work or to itself. All pipe, after having been cut, shall be reamed so as to present full pipe size. All changes in direction shall be made with proper pipe fittings. All pipe shall be installed approximately as indicated upon the plans and as specified. Piping connections to pieces of equipment shall be in accordance with the details shown on the plans or as specified. All open ends of pipe or equipment shall be properly capped or plugged during the installation in order to keep dirt and foreign matter out of the system.
3. Run-outs and branches from mains to units above the mains shall be taken from the top of the main and sloped up to the units. Run-outs and/or branches for heating units below the mains shall be taken from the bottom of the main and sloped down to the units, except where specifically noted.
4. All changes in supply main size shall be made with eccentric fittings arranged so as not to pocket entrained air.
5. All changes in directions of pipe lines shall be made with proper welding fittings for welded pipe and proper screwed joint fittings for screwed pipe and proper soldering fittings for soldered or brazed tube connections.

3.2 EQUIPMENT AND SYSTEMS

A. Dissimilar metals shall not be in contact with each other (i.e. steel and copper shall never touch). Provide dielectric fittings between dissimilar metals. Brass between dissimilar metals shall only be used under engineers written approval.

B. All equipment and systems as shown on the drawings or specified herein shall be installed in accordance with the provisions of each applicable section of these specifications and all local and state codes and regulations having jurisdiction.

C. All installations shall be performed in a workmanlike manner as determined by the Architects or Owner.

D. Accurately establish grade and elevation of all piping before setting sleeves. Arrange piping at equipment with necessary offsets, unions, flanges, valves, to allow for each part removal and maintenance, as approved.

E. Pitch steam condensate and drain piping to allow for proper drainage.

F. Offset piping and change elevation as required to coordinate with all other trades.

G. Avoid contact with any part of other mechanical or electrical systems.

H. Provide adequate means of draining and venting all units, risers, circuits and systems.

I. Conceal all piping unless otherwise specified.

J. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation.

K. Provide trap seal of adequate depth in overflow line on each drain pan installation.

L. All cleanout plugs, bushings and nipples, required for gauge and instrument installation shall be brass.

M. Do not install valves, unions and flanges in inaccessible locations.

N. Materials used within a system and between systems shall be consistent. If this is not possible, install approved dielectric fittings.

O. Ream pipes after cutting and clean before installing.

P. Refer to Specification Section 232100 - Water Systems Specialties & Equipment; for water system fill requirements.

3.3 FABRICATION AND CONNECTIONS

A. Area of interior welding/soldering shall be ventilated. Personnel shall use respirator protection in accordance with OSHA if ventilation cannot be accomplished during welding/soldering operations in the field.

B. Fabrication methods as specified in Pipe & Fittings Products, shall be as follows:

C. Welding:
1. Contractor shall provide welders who are qualified to Section IX of the ASME Boiler and Pressure Vessel Code.
2. All welds shall conform and be inspected in accordance with ASME B31.9 pressure piping.
3. Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
4. Welding can be electric arc or oxy-acetylene and shall present a complete fusion of the weld metal and parent metals for the full depth and/or thickness of adjacent butted parent metals and for the complete circumference.
5. Weld and fabrication sequence shall be arranged to avoid distortion or damage to piping and fittings. Cutting of pipe shall be done to achieve straight lines and squared surfaces.

D. Flanged Connections:
1. Flanged joints shall be carefully aligned and flange bolts, nuts and fastener bearing surfaces shall be lubricated with a heavy graphite oil mixture.
2. Initial tightening of flange bolts shall be 1/2 of the final torque and shall be tightened in a proper sequence pattern. Final tightening shall be uniform with each bolt pulling the same load. Bolts shall be re-tightened 24 hours after final tightening. Torque values shall be in accordance with industrial standards.
3. Furnish gasket material, thickness and type suitable for fluid to be handled, and design temperatures and pressures.

E. Soft Solder Joints - 95/5: Thoroughly clean, apply flux, heat mating parts and apply solder to flow over and form a complete bond of mating parts. Remove excess solder and hold each joint rigid and still until completely cooled. Soft solder shall be 95% tin - 5% antimony, Mueller Brass Co., #95; or equal. Bring soldering flux on job in 2 oz. cans only and keep sealed when not in use.

F. Screw Joints: Shall be made with standard taper pipe threads, properly cut and made up with "permatex", or equal, pipe dope applied to male ends. The use of teflon type tape shall not be permitted.

G. Grooved Connections: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. A Victaulic factory trained representative (direct employee) shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. All groove depths shall be checked manually or by grooving tool (RG5200i). A Victaulic representative shall periodically visit the job site and review installation.

H. Mechanical Press Fittings: Pipe ends shall be cut on a right angle (square) to the tube. Pipe ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the tube end with a clean rag. Visually examine the fitting sealing element to ensure there is no damage, and it is properly seated into the fitting. Insert tube fully into the fitting. Make a mark with a felt tip pen on the pipe at the face of the fitting. Always examine the tube to insure it is fully inserted into the fitting prior to pressing the joint. Utilize manufacturer's recommended tool(s) to make final connection. Sealing elements shall be verified for the intended use. Installers shall attend manufacturer's installation training class prior to start of work.

3.4 TESTING

A. Preparation and testing shall be in accordance with ASME B31.9.

B. Refer to Specification Section 230593 - Testing, Adjusting and Balancing; for adjusting and balancing of systems.

C. Preparation:
1. Leave joints including welds uninsulated and exposed for examination during the test.
2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of over-pressure during the test.

D. Hydrostatic Testing (Hydronic Systems):
   1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
   2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
   3. Examine system to see that equipment and components that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
   4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 100 psi or 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve or other component in the system under test. Make a check to verify the stress due to pressure at the bottom of vertical runs does not exceed either 90% of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.
   5. After the hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing or replacing components as appropriate and repeat hydrostatic test until there are no leaks.
   6. Clean and flush hydronic piping systems. Remove, clean and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

E. Pressure Testing and Inspection - General:
   1. Prior to acceptance and initial operation, all piping installations shall be inspected and tested to determine that the materials, design, fabrication and installation practices comply with Code Requirements.
   2. Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly or pressure tests as appropriate. Supplementary types of non-destructive inspection techniques, such as magnetic-particle, radiographic, ultrasonic, etc. shall not be required unless specifically listed herein or in the engineering design.
   3. In the event repairs or additions are made following pressure test, the affected piping shall be tested, except that, in the case of minor repairs or additions, testing shall be permitted to be omitted where precautionary measures are taken to ensure sound construction.
   4. Because it is sometimes necessary to divide a piping system into test sections and install test heads, connecting piping and other necessary appurtenances for testing, it is not required that the tie-in sections of pipe be pressure tested. Tie-in connections, however, shall be tested with soap solution after gas has been introduced and the pressure has been increased sufficiently to give some indications should leaks exist.

F. Test Preparation:
   1. Pipe joints, including welds, shall be left exposed for examination during the test. If the pipe end joints have been previously tested in accordance with Code Requirements, they shall be permitted to be covered or concealed.

2. Equipment that is not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested.
3. Where the piping system is connected to equipment or components designed for operating pressures of less than the test pressure, such equipment or equipment components shall be isolated from the piping system by disconnecting them and capping the outlet(s).

G. Test Pressure:
1. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.
2. The test pressure to be used shall be no less than 1-1/2 times the proposed maximum working pressure, but not less than 3 psig (20 kPa gauge), irrespective of design pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.
3. Test duration shall be not less than 1/2 hour for each 500 cubic feet of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet, the test duration shall be permitted to be reduced to 10 minutes. For piping systems having a volume of more than 24,000 cubic feet, the duration of the test shall not be required to exceed 24 hours.

H. Detection of Leaks and Defects:
1. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.
2. The leakage shall be located by means of an approved combustible gas detector, soap and water, or an equivalent non-flammable solution. Matches, candles, open flames, or other methods that could provide a source of ignition shall not be used.
3. CAUTION: Since some leak test solutions, including soap and water, may cause corrosion or stress cracking, the piping shall be rinsed with water after testing, unless it has been determined the leak test solution is non-corrosive.
4. Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and re-tested.

I. Test Records: Records shall be made of inspection and all tests performed. These records shall indicate which portions of the piping system conform to Code Requirements or were pressure tested.

3.5 FILLING & FLUSHING

A. Isolate system from existing.

B. Fill system and properly vent.

C. Hydrostatically test the system to check for leaks and fix any leaks as soon as discovered.

D. Start pumps to circulate water through system.

E. Blow down strainers on new equipment and clean as needed.

F. Vent all units as required.

G. Make necessary connections of new piping to existing.

H. Contractor shall be responsible to fill any glycol lost in the connection process.

I. Vent new and existing systems as required. Some existing systems may have been affected with draining for the new work.

J. Hydrostatically test new systems and insure that any discovered leaks will be repaired. Special attention is required to ensure that there is no leakage from valves, AV's or other equipment. Contractor shall be responsible for replacing ceilings or other surfaces damaged by leaks from new work.

K. If Contractor discovers severely degraded piping near areas of work, he shall immediately notify the Architect, in writing.

L. Provide written report to Architect stating the completion of above procedure and dates of completion.

END OF SECTION

SECTION 23 21 23

CIRCULATING PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of pumps and accessories.
B. Product data sheets on all components.
C. Shop drawings on all pumps and accessories.
D. Operating and maintenance instruction manuals and parts list.
E. Certified test curves for each pump.
F. Before ordering, submit construction details, coupling details and seal design.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide pumps of size, capacity, construction, speed, service, and location shown on drawings and specified hereinafter.

B. Non-overloading over entire performance range with motor capable of running continuously without undue noise, heating, sparking or overloading.

C. Guaranteed for static and dynamic balance.

D. Mechanical seals shall be used for closed systems and shall be carbon rings with ceramic mating seat. Packing type seals approved for open type systems only.

E. All materials suitable for water pressures, temperature and conditions as actually installed or required.

F. Provide with tapped connections for gauges, vent and drain.

G. Contractor fully responsible for trouble resulting from poor pump alignment.

H. With specially sized impeller if required to meet initial delivery requirements.

I. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

J. Pumps shall be base mounted centrifugal pumps with solid type volute, 175 psi W.P., suction and discharge tappings, enclosed impeller, re-greasable ball bearings with lubricated sleeve bearing frame.

K. Base mounted pumps shall be furnished on heavy structural steel mainframe with securely welded cross-members.

L. Base mounted pumps shall be single stage, end suction design with the back pull-out, capable of being serviced without disturbing piping connections.

M. Furnish pumps with flanged inlet/outlet connections. For smaller pumps with threaded connection provide threaded companion flanges.

N. Pumps shall be bronze fitted construction: bronze impeller, stainless steel impeller key, lock washer screw, steel impeller washer and shaft. Standard single mechanical seal with carbon seal ring and ceramic seat. A flexible coupler, capable of absorbing torsional vibration, shall be furnished between pump and motor and shall be equipped with a suitable coupling guard Koppers, Type ES "Elagtomeric", or equal. Pumps shall be dynamically and statically balanced.

O. Field services shall be provided by a factory trained representative to fully set-up and adjust the circulating pumps, after the installations have been completed and before the pumps are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, pump rotation, three phase motor rotation, etc. shall all be completed and checked before pumps are placed in service.

P. Circulating pump motors shall be open drip-proof design. Motors shall be premium efficient type (see schedule for %) and "VFD ready", and comply with EISA standards. Pump shaft shall have integral thrust collar and shall be supported by an oil-lubricated bronze sleeve bearing. Pump to be equipped with long-life mechanical seal.

Q. Pumps should be picked from center or left side of pump curves.

2.2 CIRCULATOR PUMPS

A. The pumps shall be single stage, canned-rotor type, in-line design. The capacities and characteristics shall be as called for in the schedules.

B. Pump casing shall be constructed of EN-GJL-250 or ASTM-A 48 Class 35 cast iron. The pump casing/volute shall be rated for 175psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with ANSI Class 125 flanges.

C. All casings shall be flanged connections.

D. The impeller and shaft shall be Class 304 stainless steel.

E. The pump and motor form an integral unit without a mechanical seal. The bearings are lubricated by the pumped liquid. No petroleum lubricated bearings will be accepted.

F. The pumps shall be able to operate as single or parallel variable speed pumps, where the speed is regulated by an on-board electronic device. The onboard electronics shall allow these pumps to run in parallel, standby or alternating modes.

G. The commissioning and set up of the pump shall be accessed through a web interface (data exchange) and use HTML 1.1 web language. The pump shall provide a port for a RJ-45 cable connection.

H. The electronics shall provide constant pressure control (Δp-c), variable differential pressure control (Δp-v) as the factory default, proportional pressure control, constant curve duty (uncontrolled pump), RPM regulation and power limitation control.

I. The pump electronics shall come standard with 2 external digital inputs and 1 external digital output to be available for additional mechanical room control.

J. The wiring/electronics enclosure shall be class 2, IP44.

K. Pumps should meet UL 778, 1004-1, 508C, CAN/CSA C22.2 #108, #100, #107.1, EMC (89/366 EEC): EN 61000, LVD (73/23/EC): EN 60335-1, EN 60335-2-51, and machine safety (98/37/EC): EN ISO 12100.

L. The pumps shall be electronically protected, be rated for continuous duty and have a built-in startup circuit. The pump electronics shall provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.

M. The pump shall be capable of being monitored 24/7 via integrated internet link.

N. The pump must be driven by an electrically commutated electrical motor (ECM) with permanent magnet rotor. The rotor magnets shall by time stable, non-toxic ceramic magnets (Sr-Fe). The electrically commuted electrical motor shall be driven by a frequency converter with an integrated PFC filter.

2.3 MOTORS

A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled.

B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%

C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.

D. Motors controlled by Variable Frequency Drive (VFD) units shall be rated for inverter duty (NEMA MG1, Part 31).

PART 3 - EXECUTION

3.1 INSTALLATION

A. All Pumps:
1. Adjust gpm of each pump to capacity called for in schedule; readjust during balancing if required.
2. Contractor is responsible for trouble resulting from poor pump installation.
3. Pumps shall be oriented to allow ease of maintenance.
4. Pumps shall be provided with inlet and discharge pressure gauges, drain plugs and valved drain piping.
5. Provide spare seal kits, secure to pump housing after installation for future use. Provide one kit for each different model and size pump.

B. Base Mounted Pumps:
   1. Provide concrete base as indicated on drawings for base mounted pumps.
   2. Level base, shim and remove all piping strain from pump casing.
   3. Align all pumps as directed by manufacturer.
   4. After pumps are aligned, install dowels to prevent shifting.

C. Contractor responsible for accurate size of base and exact location of mounting bolts.

D. Contractor responsible for trouble resulting from poor pump alignment.

E. Suction diffuser support leg shall be adjusted to prevent strain on the pump housing.

F. Inline Pumps:
   1. Contractor shall provide steel support frames for pumps. Support frames may be attached to wall and floor.
   2. Install pump level with support rods on suction and discharge sides.
   3. Pumps shall be installed per manufacturer's instructions. Pump casing shall be free of piping strain and in no case shall casing support adjacent piping.

END OF SECTION

SECTION 23 23 00

REFRIGERATION PIPING & SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Product data for all piping and specialties.

1.3 REFERENCE STANDARDS AND CODES

A. All installations and materials shall conform to applicable 2020 New York State Building Code, and local building and plumbing codes.

B. All piping shall be inspected and approved by Underwriters Laboratories and bear the UL label.

C. All installations shall conform to requirements of Owner's Insurance carriers.

D. Refer to the latest edition and applicable sections of the following:
1. American Society of Testing and Materials (ASTM)
2. American National Standards Institute (ANSI)
3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
4. Piping shall conform to ASHRAE 15 Standards.
5. American Welding Society (AWS).
6. American Refrigerant Institute (ARI).
7. Underwriters Laboratories (UL).
8. American Society of Mechanical Engineers (ASME), Code for Pressure Piping B31.5 - Refrigerant Piping.

1.4 GENERAL REQUIREMENTS

A. All materials furnished and all installations made under this specification shall conform with the applicable requirements of the codes and standards described herein.

B. Layout of equipment, piping, etc. is diagrammatic, unless detailed. Check project drawings prior to making installations for interference's with other trades and services. Owner reserves the right to make reasonable changes prior to "rough-in" without added expense. All dimensions shown are subject to verification of exact site conditions.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Refrigerant Piping (7/8" & Below): Type K, seamless soft temper ACR copper tubing coils, ASTM B-280, factory cleaned with ends capped; flare type threaded fittings, flared tube ends.

B. Refrigerant Piping (1" & Above): Type L, seamless hard temper ACR copper tube, ASTM B-88; wrought copper socket fittings, ANSI B16.22; silver brazing joints, with minimum 3 CFM nitrogen purge.

2.2 REFRIGERATION SPECIALTIES

A. Refrigerant piping specialties shall be UL listed and designed to conform to ARI Standard 760.

B. MF-1: Flexible connector for refrigerant service, size as indicated on drawings, suitable for use on ACR tubing, corrugated phosphorus bronze tube, bronze braid, braid sleeves, end fittings shall be copper female solder type. Unit shall be cleaned and dried for refrigerant service and shipped sealed. Furnish compressor connector, Flexonics Co.; or equal.

C. RSS-1: Refrigerant pipeline strainer; 500 psig maximum working pressure; forged brass body with monel 80-mesh screen and screwed cleanout plug; Y-pattern, with solder end connections.

D. Sight Glass: (Moisture/liquid indicators); 500 psig maximum operation pressure, 200°F maximum operation temperature; forged brass body, with replaceable polished optical viewing window and solder end connections.

E. Filter Dryer: 500 psig maximum operation pressure; steel shell, flange ring and spring, ductile iron cover plate with steel cap-screws and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-dryer core kit of standard capacity desiccant sieves to provide micronic filtration, including gaskets.

F. LLS: Liquid line solenoid valve; 250°F temperature rating, 400 psig working pressure, forged brass , with Teflon valve seat, two-way straight through pattern and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2" conduit adapter, and 24 Volt, 60 Hertz normally closed holding coil.

G. TXV: Thermal expansion valves; thermostatic adjustable, modulating type; size as required for specific evaporator requirements and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line and an external equalizer line.

H. HGBV: Hot gas bypass valve; adjustable type, sized to provide capacity reduction beyond the last step of compressor unloading and wrought copper fittings for solder end connections.

I. EPRV: Evaporator pressure regulating valves; pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gauge tappings, 24 Volts DC, 50/60 Hertz, standard coil and wrought copper fittings for solder end connections.

2.3 LIABILITY

A. Contractor shall be held liable throughout guarantee period for any damage from failure of piping and accessories due to poor or faulty workmanship and/or defective materials.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all specialties in accordance with requirements for refrigerant piping as recommended by the condenser manufacturer. Refer to Specifications Sections 238115 - Air Cooled Condensing Units and 238110 - Packaged Air Conditioning Units.

B. Refer to Specification section 232113 - Piping Systems and Accessories; for pipe identification, nameplates, hangers and general pipe installation.

3.2 FABRICATION

A. Area of interior brazing shall be ventilated. Personnel shall use respirator protection in accordance with OSHA standards if ventilation cannot be accomplished during operations in the field.

B. Silver Alloy Brazed Joints - in accordance with AWS A5.8, Class BAg1, shall be prepared and made up in complete conformity with the instructions of the brazing alloy and flux manufacturer and shall include complete and thorough cleaning of the mating parts after which an even coating of flux shall be applied to the mating parts. The mating shall be assembled, held rigid and heat applied evenly by oxy-acetylene torch to the complete areas to be joined after which silver alloy shall be flowed into the joint. Silver brazing alloy flux shall be low silver content (15%), melting at 1185°F and free flowing at 1300°F, suitable for joints between copper, brass and bronze. Silver brazing alloy flux shall be specifically for low temperature silver brazing alloy, free flowing at 1100°F. Silver brazing alloy flux shall be Handy & Harman, "Handy-Flux"; or an approved equal. Silver brazing alloy flux shall be brought on the job in only one pound containers and shall be kept sealed when not in use. Silver brazing alloy shall be Handy & Harman, "Sil-Fos"; or an approved equal.

3.3 TESTING AND SYSTEM FILLING

A. Examine rough-in for refrigeration piping systems to verify actual locations of piping connections prior to installation.

B. Install piping free of sags or bends with ample space between piping to permit proper insulation applications.

C. Inspect, test and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter IV.

D. Repair leaking joints using new materials and retest for leaks.

E. Charge system using the following procedures:
   1. Install core in filter dryer after leak test but before evacuation.
   2. Evacuate refrigeration system with vacuum pump; until temperature of 35°F is indicated on vacuum dehydration indicator.
   3. During evacuation apply heat to pockets, elbows and low spots in piping.
   4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
   5. Break vacuum with refrigeration gas, allow pressure to build up to 2 psi.
   6. Complete charging of system using new filter dryer core in charging line. Provide full operating charge.

END OF SECTION

SECTION 23 25 00

CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Section, apply to the work of this section.

1.2 RELATED SECTIONS

A. 232115 - Initial Fill and Cleaning

B. 230593 - Testing, Adjusting and Balancing

1.3 SUBMITTALS

A. Product data and shop drawings for each type of product specified. Include manufacturer's technical product data, rated capacities of selected equipment clearly indicated, water-pressure drops, furnished specialties and accessories.

B. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturers installed wiring and field installed wiring.

C. Material safety data sheets of all chemicals.

D. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

E. Operation and maintenance manuals. Include detailed manufacturer's instructions and parts list for each item of equipment, control and accessory. Include troubleshooting maintenance guide.

1.4 GENERAL REQUIREMENTS

A. Immediately upon signing a Contractor for the MECHANICAL portion of the project, that Contractor shall engage the service of a qualified independent testing lab, draw a sample of the raw water to be used in the finished project boiler system and have the sample tested. This testing shall at a minimum indicate the following:
   1. Total hardness as C_aCO_3, ppm
   2. Calcium as C_aCO_3, ppm
   3. Total alkalinity
   4. Sulfate as SO_4, ppm
   5. Chloride as CL, ppm
   6. Silica as $S10_2$
   7. Total Phosphate
   8. PH
   9. Specific Conductance, Micromhos @ 25°C
   10. Total Iron as Fe, ppm

11. Total Copper as Cu, ppm
12. Nitrite as NO_2, ppm

B. Contractor shall provide the services of a qualified water treatment contractor with a minimum of 10 years continuous service in testing and treating of both open and closed hydronic system.

C. Water treatment contractor shall supervise the installation of water treatment, instruct operating personnel orally and in writing in the performance of the control tests and their interpretation and supervision through periodic visits, the progress of the water treatment program.

D. Such service shall be provided during construction for start-up of systems and owners acceptance for beneficial use. No less than six visits will be provided for on-site supervisory service testing.

E. Provide all equipment and materials as specified and as required to provide complete and operational systems.

F. Provide complete water treatment analysis including testing, lab analysis, analytical test reports and proposed/suggested water treatment plan including all chemicals required to implement the plan.

G. Contractor shall coordinate proposed chemicals to be used with all materials in the system and equipment manufacturer's recommendations to ensure compatibility.

1.5 REFERENCE STANDARDS

A. American Society for Testing & Materials - Latest Edition, Applicable Sections

B. National Electric Code NFPA-70

C. American Society of Heating, Refrigeration & Air Conditioning Engineers (ASHRAE)

PART 2 - PRODUCTS

2.1 COMMON EQUIPMENT

A. BFP-1: Backflow preventer, 1" NPT connections, bronze body construction with Celcon check seats. Furnish bronze strainer and full port bronze ball valves. Watts Regulator Co., Model #909 SQT; or equal.

B. CFP-1: Chemical feed pot, 5 gallon size, steel tank and head, iron cap with gasket. Unit shall have four connections for flow, vent, and drain. Provide with leg extensions for floor mounting. Unit shall be constructed in accordance with ASME pressure vessel code. Griswold Water Systems Model #DB-5-GE-CS-A-250; or an approved equal.

C. CFP-2: Chemical feed pot with bag filter, 2 gallon size, steel tank, cast iron cap with gasket, 5 micron filter bags. Neptune Model #FTF-2; or an approved equal. Provide six extra 5 micron replacement bags.

D. PRV-1: Pressure reducing valve 1" set at 20 psig screwed connections. Watts regulator Model #223LP: or equal.

E. WM-1: Water meters for make-up water system. Direct magnetic drive type, cast bronze housing hermetically sealed register, totalizing type in gallons, 5/8" threaded end connections, contact ratings 115V, 5A; Badger Meter Utility Division Model #25; or approved equal.

PART 3 - EXECUTION

3.1 TESTING

A. Contractor shall provide the services of a qualified water treatment contractor with a minimum of 10 years continuous service in testing and treating of both open and closed hydronic systems.

B. Contractor shall provide as a minimum:

C. One (1) year service, treatment and water treatment chemicals of all open and closed systems as specified from the date of systems acceptance.

D. All equipment and chemicals as specified and required to provide a complete and operational system.

E. Provide the service of a qualified independent testing lab to evaluate system.

3.2 INSTALLATION

A. All equipment shall be installed per manufacturer's recommendations.

B. All chemicals shall be stored in containers approved by chemical manufacturer strictly adhering to any special ventilation requirements.

END OF SECTION

SECTION 23 25 10

ANTI-FREEZE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Product data.

1.3 REMOVALS

A. If any glycol is removed from the building's systems and is to be disposed of, the Contractor is responsible to remove the glycol from the site and have it properly disposed of with respect to EPA and all local guidelines. The contractor shall carry the cost of removal within his bid. Putting the product down a drain will not be acceptable.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Contractor is responsible for supplying the proper amount of the product to the heating and chilled water glycol systems, contractor to reference contract drawings for piping sizes and lengths to determine volume. Contractor is responsible for filling system to 40% concentration. A written report is to be completed as specified in Part 3 – Execution.

B. All anti-freeze on this project is to be 100% virgin anti-freeze. Any anti-freeze that is recycled or partially recycled formula shall be rejected without review. The submittal must state that anti-freeze is 100% virgin. If anti-freeze has been installed and found to have recycled component it shall be removed and replaced with new 100% virgin at contractor's expense.

2.2 PROPYLENE GLYCOL, DOWFROST (PG)

A. Dow Chemical Co. inhibited glycol based heat transfer fluid, 95.5% glycols and 4.5% inhibitors and water by weight. Capable of protection from freezing to -23°F @ 42% and -12°F @ 30% and boiling to 250°F. Fluid shall contain special corrosion inhibitors that passivate the surface of metals and buffer any acids that form from normal oxidation. Fluid shall have a low acute oral toxicity.

2.3 ANTIFREEZE TESTER

A. Model #YA845, Snap-On-Tools Corp.; or equal. Contains six temperature compensating discs to show degree of protection thru a magnified tube. Shall have a scale range of 25°F to overprotection. Also includes flexible rubber hose.

2.4 INJECTION TANKS (IT-1)

A. Chemical Feed system for glycol solution. Each system to include one 50 gallon polyethylene tank with hinged cover and one feed pump with 1/2 HP motor mounted below tank. Motor to be 115V/1Ph. Pump suction of PVC tubing to include ball valve and strainer. Pump discharge of schedule 80 PVC pipe includes ball valve and check valve. Additional accessories to include: PVC float switch, pressure switch, relief valve, pressure gauge on discharge and NEMA 12, 115V control panel. Controls to include a 24 volt control circuit, H-O-A for pump, low tank level indicator and pump "on" indicator.

PART 3 - EXECUTION

3.1 GENERAL

A. Fill system 100% with water. Hydrostatically test the system to check for any leaks.

B. Remove all air from the system as per filling instructions. See Section 232113 - Piping Systems & Accessories.

C. Partially drain system to accommodate the appropriate quantity of glycol.

D. Disposal of anti-freeze: all fluid removed from fluid cooler which contains anti-freeze solution shall be pumped into temporary tankage and disposed of offsite in an approved manner. Do not drain fluids containing anti-freeze on the ground or directly into building floor drains

E. Add the appropriate amount of glycol fluid to the system and circulate for 24 hours to insure complete mixing.

F. Test concentration of solution using tester specified and add any necessary amount of glycol to reach the desired level.

G. Provide written report to Architect stating volume of antifreeze solution added, concentration level of antifreeze and expected freeze point of solution.

END OF SECTION

SECTION 23 33 00

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of all components.

B. Product data sheets on all equipment.

C. Submit shop drawings on all equipment. Include all performance and dimensional data.

1.3 GENERAL REQUIREMENTS

A. All control dampers shall have published performance data taken from test made in accordance with AMCA Standard 500 and in compliance with the AMCA certified ratings program for air performance and air leakage performance.

B. All fire dampers shall be rated for 1-1/2 hrs (unless specifically noted otherwise) under UL Standard 555 and shall meet NFPA 90A construction requirements.

C. Backdraft dampers shall have performance data published under the guidelines of AMCA and conform to all safety standards as set forth by NFPA 90A.

PART 2 - PRODUCTS

2.1 VOLUME DAMPERS

A. Provide where indicated on drawings or required to control air flow, for air balancing, size as required, manually operated.

B. For Rectangular Ducts up to 12" Max Dimension: Single blade volume damper for use by air balancing contractor. Damper may be fabricated by sheetmetal contractor. Damper blade shall be fabricated from stiff material and be free from operating noise. Ensure sufficient clearance between damper blade and duct wall to prevent noise. Provide external position indication and locking quadrant.

C. For Rectangular Ducts Over 12": Furnish and install where indicated on drawings, size as required, manually operated, opposed blade damper, 16 ga. galvanized steel construction, concealed linkage, with manual locking quadrant. Model #VCD-20, Greenheck Fan Corporation; or equal.

D. For Round Ducts: When volume damper is not an integral part of branch connection, furnish and install where indicated, size as required, manually operated, round air balancing damper, galvanized steel construction with manual locking quadrant. Model VCDR-53, Greenheck Fan Corporation.

E. BD-1: Backdraft damper, nonmetallic type with blades constructed of neoprene coated fiberglass. Extruded aluminum channel. Model #BD51, Pottorff Mfg.; or an approved equal. Don't have a vinyl blade damper.

F. BD-2: Counter balanced backdraft damper, constructed of 75 aluminum blades with neoprene blade seal and steel axles will ride on ball bearing. Model #EM-30, Greenheck Fan Corporation.

G. OBVD-1: Opposed Blade Volume Damper, aluminum construction, parallel blade, Oilite Bronze bearings, Stainless steel jamb seals and vinyl blade seals, stainless steel linkage. Model #VCD-43, Greenheck Fan Corporation.

2.2 REMOTE CONTROL DAMPER REGULATORS

A. RC-1:

1. Wall or ceiling mounted remote damper regulator. Cover plate shall be round, 3-1/2" diameter with one RJ-11 cable plug-in port.
   a) Color shall be coordinated with the architect.
   b) Model J50, United Enertech.
2. Wall or ceiling mounted remote damper regular. Cover plate shall be rectangular, with 1, 2, 3, 4, 6, or 12 RJ-11 cable plug-in ports as called for on the drawings.
   a) Color shall be coordinated with the architect.
   b) Model J100, United Enertech.
3. Round Duct: Furnish remote control circular damper, i-3, as manufactured by United Enertech. Furnish damper and RJ-11 cable in lengths sufficient for installation per drawings. Damper frame shall be minimum 24 ga galvanized steel, 8" deep, round blade damper mechanically fastened to blade, zinc plated steel pin axles, nylon 6/6 molded synthetic bearings, vertical or horizontal depending on drawings, DC actuated voltage, mill galvanized finish.
4. Rectangular Duct: Furnish remote control rectangular damper, i-4s, as manufactured by United Enertech. Furnish damper and RJ-11 cable in lengths sufficient for installation per drawings. Damper frame shall be minimum 18 ga galvanized steel, 5" deep, 16 ga galvanized rectangular blade damper mechanically fastened to blade, zinc plated steel pin axles, bronze oilite bearings, vertical or horizontal depending on drawings, DC actuated voltage, mill galvanized finish.
5. Provide Power Balance Remote Controller: Furnish 9V remote controller (with 2 batteries) and 7 foot RJ-11 cable for testing and balancing of remote control dampers. Turn over power balance remote controller to owner after testing and balancing.

2.3 FIRE DAMPERS

A. FRD-A: Fire dampers used in transfer air sleeves between adjacent rooms above ceilings, UL listed 1-1/2 hour rating. Nailor Industries Model #0110 or equal.

B. FRD-B: Fire dampers shall be manufactured, tested and labeled in accordance with UL 555 Safety Standard for Fire Dampers - Sixth Edition, June 1999, and shall have 1-1/2 hour fire resistance rating. Each fire damper shall bear a UL label verifying fire resistance rating in addition to intended mounting position. Fire dampers shall be suitably constructed for vertical or horizontal installation as required for each specific location. Each fire damper shall be complete with a 165°F (74°C) UL Listed fusible link. Fire dampers shall each include a steel sleeve of appropriate length/gauge and retaining angles, supplied by damper manufacturer to ensure proper installation in accordance with damper manufacturer's instructions. Damper to have blades out of air steam. Contractor shall provide and install an access door at each fire damper, of appropriate size to allow for inspection, testing and fusible link replacement. Information submitted for approval shall include confirmation of UL qualifications, pressure drop data and manufacturer's installation instructions. Fire dampers shall be Nailor Industries Models 0120 (Type B), or equal. Use Model 0130V or 0130H for round ducts.

C. FRD-S: Provide fire/smoke dampers where indicated on drawings. UL 555S classified Class II leakage rating at 250 degrees and UL 555 listed 1-1/2 hour labeled. Nailor Model # 1270ERL with min. 16" long 20 gauge sleeve and 120 volt electric actuator, with actuator out of airstream, and 165°F heat responsive device. Contractor shall provide and install an access door at each fire damper, of appropriate size to allow for inspection and testing. Electrical contractor shall furnish smoke detector to heating contractor – heating contractor to install within 5'-0" of damper. Install detector per manufacturer's recommendations and requirements.

2.4 DUCT ACCESS DOORS

A. Furnish and install where indicated on plans and/or required for access to life safety dampers, control probes, etc.; galvanized door with manual lock(s), double wall, 1" internal fiberglass insulation, galvanized steel frame, foam gasket seal, minimum 24 gauge construction. Label each access door at fire dampers with "Fire Damper" in letters no less than 1/2" high.
   1. Hinged Type: Model #H-10, Buckley Air Products
   2. Double Latch Type: Model #C-10, Buckley Air Products

2.5 ARCHITECTURAL ACCESS DOORS

A. Ceiling/Wall Access Door: door and frame for use in existing ceiling or walls. Door and frame fabricated from galvanized steel, thickness as scheduled, with rounded edges and concealed pivoting rod hinge. Frame shall be one piece construction with no miters or welds exposed on face. Door shall include screw driver type latch mechanism.

B. For Existing Ceilings: Provide concealed 1-1/2"x 1-1/2" support angles to be used as a sub-structure to support door frame above existing ceiling.

C. For Fire Rated Doors: Doors shall be UL Listed for fire rated service as scheduled. Door shall include heavy duty spring closer.

Tag	**AD**	**ADF**
Model #	BNTC 24x24	BIT 24x24
Manufacturer	Babcock-Davis	
Fire Rating (hours)	None	1.5
Fire Rating Label	None	B
Steel Thickness	16 gauge	16 gauge
Size (inches)	24x24	24x24
Weight (lbs)	16	24.5
Latches (Qty)	3	1
Notes	(1)(2)	(1)(2)

Notes:

(1) Finish factory prime coat, contractor shall field paint white to match ceiling where located.

(2) Contractor shall verify actual size prior to ordering if required to fit actual ceiling tile arrangement, size may be adjusted to 22x22. However, no gaps are to be allowed from door frame flange and adjacent existing ceiling tiles around perimeter.

2.6 CODE REQUIREMENTS

A. All work shall be in accordance with all applicable codes including NFPA 90A, 90B, and SMACNA requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all equipment in strict accordance with manufacturer's instructions.

3.2 DAMPERS

A. Contractor to furnish all required hardware to complete installation of air split damper and regulator.

B. Provide access doors for dampers not accessible from grilles.

C. Dampers shall be installed so as not to cause stress or strain on the frames. Fasteners shall not interfere with proper operation of blades or linkages.

D. Lubricate and thoroughly clean all moving parts according to the manufacturer's recommendations before initial operation.

E. Seal all seams.

F. Make all necessary adjustments to linkages to insure dampers open fully and close tightly over full stroke of actuator.

G. Replace any damaged parts including blades, seals, linkages, etc.

H. Install automatic vent damper in strict accordance with manufacturer's instructions and NFPA 54.

END OF SECTION

SECTION 23 33 10

DUCTWORK HANGERS & SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. See Section 233330 for submittal requirements.

1.3 WORK INCLUDED

A. Contractor shall provide all hangers and supports for all ductwork and air system equipment and accessories.

B. Contractor shall field verify and coordinate all ductwork hangers and supports, dimensions, clearances, and ductwork elevations with new and existing building structure.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. Section 233330 - Low Velocity Ductwork

B. Section 230713 - Duct Insulation

1.5 QUALITY ASSURANCE

A. SMACNA Manual: Methods of supporting ductwork shall be in accordance with the SMACNA Manual, Section 1 - Low Velocity Systems", unless otherwise shown on the drawings or specified herein.

B. SMACNA - Sheetmetal and Air Conditioning Contractors National Association, Inc.

C. Electrically operated and power actuated tools for installing welded studs and power driven fasteners shall be listed by a nationally recognized test agency.

PART 2 - PRODUCTS

2.1 DUCT HANGERS

A. All Hangers Shall Be Rod Type Hangers: Mild carbon steel, unless otherwise specified; fully threaded or threaded each end, with (2) removable nuts each end for positioning and locking rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

B. Hangers for ducts shall be as specified in the SMACNA Manual, with the following exceptions:
   1. Lower hanger attachments for rectangular duct with any dimension 18" and above shall be trapeze hangers, supported by threaded rods (3/8" dia. min.).
   2. Trapeze hangers shall be minimum 1-1/2" x 1-1/2" x 1/4" angle or larger size as required by larger or heavier ductwork. Ductmate trapeze hanger size AS and AT is acceptable.
   3. Lower hanger attachments for rectangular duct with maximum dimension less than 18" may be flat strap attached directly to duct. Fasteners penetrating ducts must be completely sealed.
   4. Wire used as supports or as banding shall not be acceptable.
   5. Fasteners used on hanger system shall not penetrate supported ductwork. (Exception: Flat strap hangers, see above.)
   6. Threaded support rods shall utilize sufficient support, jamb, and lock nuts to allow adjustment of duct heights.

2.2 MISCELLANEOUS FASTENERS AND UPPER HANGER ATTACHMENTS

A. Machine Bolts and Nuts: Galvanized or cadmium plated steel.

B. Steel "C" Clamp with Locknut: Elcen Co.; No. 29L, with 25B steel retaining clips.

C. Structural Aluminum Shapes and Aluminum Plates.

D. Structural Steel Shapes and Steel Plates: ASTM A-36, shop primed.

E. Self Drilling Expanding Fasteners: Phillips type.

2.3 BRANCH FITTINGS, JOINTS & TURNING VANES

A. Provide supports necessary for lengths over 16" or heights over 8".

PART 3 - EXECUTION

3.1 UPPER HANGER ATTACHMENTS

A. General Notes: Upper hanger attachments for ductwork shall be secured to overhead structural steel or steel bar joists wherever possible, unless otherwise specified.

B. In addition, when required by ductwork support spacing schedules, provide intermediate structural steel members, framed to span the structural steel or steel bar joists. The minimum size of structural steel members, for use as intermediate steel framing, shall be 2-1/2" x 2-1/2" x 1/4" steel angles. Intermediate steel members shall be shop prime coated prior to installation. Intermediate steel will be sized for span and load to show no deflection.

C. Secure upper hanger attachments to bar joists at the panel points of joists.

D. Do not drill holes in main structural steel members.

E. Exercise extreme care in the field drilling of holes in precast or pre-stressed concrete work, so as to avoid damage to reinforcing. Power driven types of fastening devices shall have be utilized in the attachment of hangers to precast or pre-stressed concrete work.

F. Upper hanger attachments shall be as specified in the Manual, with the following exceptions:
   1. Do not use flat bar, bent rod, power actuated drive pins or expansion nails as upper hanger attachments in concrete construction.

G. Attachment to Structural Steel: Secure to steel beams with beam clamps, welded studs, power actuated fasteners, or "C" clamps with lock nuts and minimum 1/8"x1" wide safety bars.

H. Do not use power actuated fasteners except by written permission from the Engineer's Representative.

I. Do not attach welded studs or powder actuated fasteners to steel less than 3/16" in thickness.

J. Do not use power drive on beam clamps.

K. Attachment to New Poured Concrete Construction: Support hangers from concrete insets. Properly locate and install concrete inserts in concrete form work as required, in ample time so as not to delay the construction work. Bolt band iron hangers to inserts with 3/8" bolts. Screw rods into proper size inserts and secure with lock nuts and washers.

L. Attachment to Cellular Steel or Fluted Metal Decks: Do not support ductwork from cellular steel or fluted metal roof decks. Attach hangers to structural steel members wherever possible, and where required intermediate structural steel supporting members shall be provided, framed to span the structural steel.

M. For attachment to overhead cellular steel or fluted metal decking, other than roof decks, hangers may be attached by means of welded studs with double nuts. The maximum load on any one stud shall be 250 lbs**. UNDER NO CIRCUMSTANCES SHALL UPPER ATTACHMENTS PENETRATE STEEL DECKING, OR ROOF DECK.**

N. Riser Supports: Support vertical rectangular ducts by means of two steel angles or channels, anchor bolted to floor slab or adjacent structural member at every floor through which the riser passes. Steel angles or channels shall contact a transverse joint and be secured to the joints by means of 1/8" bolts, or by welding.

O. Steel angle or channel support sizes shall be as follows:

Max. Side Dimension	Support Angle	Support Channel	Bear on Concrete or Structural Support
36"	1"x1"x1/8"	1"x1/2"x1/8"	2"
48"	1-1/2"x1-1/2"x1/8"	1-1/2"x3/4"x1/8"	3"
60"	2"x2"x1/8"	2"x1"x1/8"	3"
Over 60"	2-1/2"x2-1/2"x3/16"	2"x1"x3/16"	4"

3.2 DUCT HANGER SPACING

A. The duct hanging method must be in accordance with this specification and is subject to Engineer's approval.

B. Duct hanger spacing shall be in strict accordance with SMACNA and as follows:

1. Rectangular Duct Hangers Min. Sizes:

Max. Half of Duct Perimeter	Rod Pair at 10'Spacing	Rod Pair at 8'Spacing	Rod Pair at 6'Spacing	Rod Pair at 4'Spacing
Up to 72	1/4"	1/4"	1/4"	1/4"
73 to 96	3/8"	1/4"	1/4"	1/4"
97 to 120	3/8"	3/8"	1/4"	1/4"
121 to 168	1/2"	3/8"	3/8"	3/8"
169 to 192	1/2"	1/2"	3/8"	3/8"
Above	SEE SMACNA FOR SPECIAL CONDITIONS			

2. Round Duct Hanger Strap Sizes:

Duct Diameter	Strap Hangers	Max. Spacing
Up to 26"	One 1" x 22 Ga.	12 Ft.
27" - 36"	One 1" x 18 Ga.	12 Ft.
37" - 50"	One 1" x 16 Ga.	12 Ft.
51" - 60"	Two 1" x 18 Ga.	12 Ft.

See SMACNA, Table 5-3 for allowable loading for trapeze angles.

END OF SECTION

SECTION 23 33 30

LOW VELOCITY DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTAL

A. Layouts of duct systems shown on contract drawings are diagrammatic. Actual duct layout and fabrication shop drawings are required to be submitted for approval. Coordinate these shop drawings with other trades and existing conditions, as required for proper installation, prior to submittal.

B. Please note that ductwork CAD files will not be given to the contractor. Contractor is expected to field verify and draw all ductwork.

C. General duct layout, 3/8" = 1'-0" scale, of all duct systems, including dimensions and elevations.

D. Ductwork shop drawings shall be fabrication drawings, showing actual intended location of ductwork and clearances. Ductwork elevations and architect's ceiling heights shall be noted on drawings.

E. All areas where ductwork is below the architect's ceiling height shall be noted and clouded. **FAILURE TO NOTE BOTH BOTTOM OF DUCT ELEVATIONS AND ARCHITECT'S CEILING HEIGHTS WILL BE CAUSE FOR REJECTION.**

F. Duct shop drawings shall show actual existing and/or new structural steel arrangements, and shall be coordinated to properly fit in intended spaces.

G. Sheetmetal contractor shall verify that ductwork layouts are coordinated with all other construction trades which might cause a conflict. This contractor is required to provide copies of duct shop drawings to all applicable contractors for their use in coordination efforts.

H. Immediately notify Engineer if a duct layout conflict is discovered.

I. Submittal packages which do not include all items listed in this section will be considered incomplete and will be returned to the contractor without review.

J. If a significant number of shop drawings are required, individual drawings may be submitted for review. Duct construction booklet must accompany initial submittal or it will be considered incomplete and returned without review.

K. Fabrication of installation of ductwork shall not be permitted unless duct shop drawings and construction booklet are approved by Engineer.

L. Contractor will be required to remove ductwork installed without duct submittals conforming to requirements of this section and approved by the Engineer.

1.3 DUCT CONSTRUCTION BOOKLET

A. Duct construction booklet shall be submitted with initial duct layout drawing submittal.

B. The following is a basic list of materials, devices, methods, etc. that shall be described in the ductwork construction booklet submittal:
   1. Manufacturer's data sheets for all purchased duct accessory components (damper hardware, duct liner, access doors, etc.)
   2. Gauges of ductwork, material, method of construction, types of reinforcing and joints, etc.
   3. Transverse and Longitudinal Joints
   4. Duct Fitting Construction
   5. Duct Sealing & Sealants
   6. Duct Hangers, Type, Spacing, Upper, Lower
   7. Special Supply Air Duct Construction Details (i.e. 14 gauge)
   8. Branch Duct Connections Details
   9. Acoustic Lining
   10. Flexible Ductwork
   11. Flexible Connection (to AHU's etc.)
   12. Access Doors
   13. Duct Accessories
   14. Volume Dampers
   15. Locking Quadrants
   16. Remote Control Damper Regulators
   17. Turning Vanes
   18. Penetration Trim Frames
   19. Fire Damper Installation Details
   20. Fire Proofing Penetrations, Chase Safing
   21. Specialty Duct Construction and Installation Methods
   22. Other Specialty Equipment Connections

1.4 RELATED SUBMITTALS

A. The following shop drawings are required under other specification sections and must be submitted as separate packages (in addition to ductwork submittals detailed in this section).
   1. Exhaust Fans
   2. Louvers
   3. Roof Hoods
   4. Diffusers, Registers, Grilles
   5. Ductwork Accessories:
      a) Special volume control dampers
      b) Fire and/or smoke dampers
      c) Remote control damper actuators

1.5 WORK REQUIRED

A. Contractor shall furnish materials and labor and shall fabricate and erect all sheetmetal ductwork including connections to units, all dampers, registers, diffusers and accessories as shown on the drawings, described herein and/or as required to make the air handling installations complete.

B. Complete supply and return air ductwork serving all units.

C. All exhaust air ductwork.

D. Relief air ductwork.

E. Ductwork and connection into existing air systems where applicable in existing building.

F. Installation of all intakes and discharges including exhaust fans, louvers, roof hoods.

G. Specialty ductwork and specialty equipment for applicable kitchen, fume exhaust, safety hoods, and other specialty systems where indicated.

H. Modification of existing air system equipment to meet new air system requirements (i.e. - fan drives, belts, sheaves, fan motors, etc.).

I. Complete balancing of all air systems.

J. Contractor shall field verify and coordinate all ductwork, dimensions, clearances, and ductwork elevations with existing building structure.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230005 - MECHANICAL Work General
B. Section 230593 - Testing, Adjusting & Balancing
C. Section 230713 - Ductwork Insulation
D. Section 233300 - Ductwork Accessories
E. Section 233310 - Ductwork Hangers & Supports

1.7 QUALITY ASSURANCE

A. SMACNA Manual: Gauges of materials, fabrication and installation of ductwork shall be in accordance with the SMACNA Manual, Section 1 - "Low Velocity Systems", unless otherwise shown on the drawings or specified herein.

B. SMACNA - Sheetmetal and Air Conditioning Contractors National Association, Inc.

C. New York State Energy Code.

D. 2018 New York State Building Code.

E. Electrically operated and power actuated tools for installing welded studs and power driven fasteners shall be listed by a nationally recognized test agency.

1.8 PRODUCT HANDLING

A. Protection: Use all means necessary to protect materials of this Section before, during and after installation and to protect installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

C. Delivery and storage: Deliver all materials to the jobsite in their original unopened containers with all labels intact and legible at time of use. Store in strict accordance with the manufacturer's recommendations.

D. Ductwork that is shop fabricated shall be delivered to the site in quantities acceptable to the storage area that the General Contractor has available.

PART 2 - PRODUCTS

2.1 GENERAL

A. For the purpose of establishing equality, certain manufacturers have been specified herein. In no way shall this be construed as limiting competition. Products of other manufacturer's may be proposed in accordance with the provisions of the Contract.

B. Fabrication: All ducts, unless otherwise allowed, shall be true to dimensions indicated upon plans, straight and smooth on inside, with neatly finished joints. Securely anchor to building construction in acceptable manner, free from vibration under all conditions of operation, and properly brace and reinforce with aluminum angle or other structural members. Slip joints shall be in direction of flow. Elbows shall have centerline radius equal to 1-1/2 times width of duct.

C. **NOTE: ALL DUCTWORK SERVING A VAV SYSTEM SHALL BE RATED FOR 3 IN. W.G. STATIC (POSITIVE OR NEGATIVE) AND SHALL CONFORM TO SMACNA. ALL OTHER DUCTWORK SHALL BE RATED FOR 2 IN. W.G. STATIC (POSITIVE OR NEGATIVE).**

D. All ductwork with a 4 to 1 ratio, and higher shall have a Condu-lock internal reinforcing at midpoint between joints, both horizontally and vertically.

E. All ductwork 10 ft downstream of a VAV to be internally lined, whether shown or not.

2.2 SHEETMETAL

A. Galvanized Steel: ASTM A653/A653M lock forming quality – zinc-coated (galvanized): ASTM A653/A653M commercial coating class – 0.9 oz. per sq. ft.

B. 2" W.G. Low Pressure Rectangular Duct Construction:

1. Note: These gauges are 1 gauge heavier than required by SMACNA.

Longest Side	Gauge	SMACNA Rigid Class (1)	Stiffeners Spacing
0-12"	24	A	5'
13-30"	22	B	5'
31-54"	20	B	5'
55-84"	18	E	5'

C. 2" W.G. Low Pressure Round Duct Construction:

Diameter	Gauge
0-12"	26
13-24"	24
25-36	22

D. Aluminum Ductwork: Use 1 gauge heavier than required by SMACNA Standards.

2.3 LONGITUDINAL JOINTS FOR RECTANGULAR DUCT

A. Seams shall be formed and assembled with proper dimensions for tight and secure fit. Notching shall be minimal consistent with transverse joint requirements.

B. Standard longitudinal seam shall be Pittsburgh Lock Standing seams are not acceptable.

2.4 TRANSVERSE JOINTS FOR RECTANGULAR DUCT

A. Joint type shall be selected on the basis of ± 2" wg. Pressure class, materials, support intervals, and other provisions for proper assembly of ductwork.

B. All transverse joints with any dimension greater than 16" shall be constructed with the Duct Mate system; or an approved equal. All transverse joints 16" and less shall be slip and drive.

C. Contractor shall submit for approval the intended joint type with the duct construction detail book submittal.

D. Turning Vanes and Vane Runners: Weld runners to duct and weld vanes to runners, all as shown on the drawings. All turning vanes shall be air foil type.

2.5 DUCTWORK FITTINGS

A. All elbows on main supply ducts shall be radiused type fittings.

B. Where square elbows are allowed, turning vanes shall be used. Square fittings without turning vanes are not permitted.

2.6 BRANCH CONNECTIONS

A. Furnish and install where indicated on drawings, size as required, the following:
   1. For rectangular branch ducts: 45 degree cinch collar, each branch duct to include a volume damper.
   2. For round duct branches: High efficiency take-off type fitting with integral volume damper.
   3. Branch duct connections regardless of size or type will be fully sealed by an approved method.

2.7 ROUND DUCT CONSTRUCTION

A. Round duct seams shall be spiral lockseam type. Snap lock or lap seams are not acceptable. Duct and fittings shall be single wall Uni-Seal Duct, United McGill Corp.; or equal, unless noted otherwise.

2.8 FLAT OVAL

A. Duct shall be of a spiral lock seam construction with a mechanically formed seam locking indentation evenly spaced along the spiral seam. All spiral duct 8" diameter and larger shall incorporate multiple corrugations between spiral seams. Duct shall be galvanized steel that conforms to ASTM standards A653 and A924 and be in accordance with SMACNA 2005 Duct Construction Standards and shall conform to SMACNA's MECHANICAL Duct Construction Standards for +10" water gauge pressure. Connection methods shall be slip-fit with all joints being sealed by the installer during the installation process. The type of sealant used as well as the method and level of application should be in accordance with the sealant manufacturer's published installation instructions and as specified hereinafter. All fittings that are either spot-welded or button punched construction are internally sealed. All transitions and divided flow fittings which convert from flat-oval to round 60" diameter or less.

2.9 DUCT SEALING REQUIREMENTS

A. All ductwork, fittings, connections to equipment, damper connections, branch duct connections, and other duct system joints shall be sealed in accordance with the duct system sealing schedule.

B. The term sealed requires the use of liquids, mastics, combination mastics and open weave fabric, gaskets, or other sealing compounds made exclusively for duct work applications. Oil base caulking and glazing compounds shall not be used.

C. Tapes shall not be applied to metal surfaces or to dry sealant.

D. Liquid: As recommended by the manufacturer of the ductwork.

E. Mastic: 3M Co. #ED-800 or 900.

F. Gaskets: Soft neoprene or reinforced inert plastic of the self conforming type.

G. Special Note: All sealants must be applied in ambient temperatures exceeding manufacturer's recommendations to insure proper setup.

H. Seal all penetrations with Manville Pyro-Fiber safing; or equal. Provide safing clips and joint sealant.

2.10 DUCT SYSTEM SEALING SCHEDULE

A. Supply, Return & Exhaust Ductwork: Completely seal all transverse joints and longitudinal seams.

B. Connection to Equipment: Use flanged connections to equipment, provide gasket to seal between flanges. Bent sheetmetal is not acceptable as a flange. Use steel angle or heavy gauge flat bar as a back up surface.

2.11 DUCT LINER

A. Furnish and install where indicated on drawings, acoustic duct liner.

B. Duct liner shall: made from flame attenuated glass fibers bonded with a thermosetting resin, air stream side to be coated with a non abrasive black surface. Furnish 2" thick, permacoat Linacoustic manufactured by Johns Manville; or equal. Duct liner rated for use at 250°F, 5000 fpm, with a k-factor of 0.25 and acoustical performance NRC of 0.70.

C. Ductwork having internal lining is not to be externally insulated, unless otherwise noted.

D. Any lined duct that has had water on the liner, shall be deemed unusable and will be required to be immediately removed from the site. The contractor shall provide an new section at no cost to the owner.

E. Note: Duct sizes shown are net inside duct dimensions, not including internal liner. Failure to comply with this requirement will be grounds for rejection.

2.12 FLEXIBLE DUCTWORK

A. Furnish and install where indicated on drawings, bi-directional reinforced metallized vapor barrier with triple ply stand-up seam; acoustically rated black CPE liner permanently bonded to a coated spring steel wire helix and supporting a thick blanket of fiberglass insulation. UL listed, Class 1 air duct. Flexible Tubing Division, Thermaflex, Type MKE; or equal. For connections to rectangular duct, use Bellmouth fittings with integral volume damper. Flex duct is not to be connected directly to rectangular main ducts. Duct centerline radius to duct diameter ratio not to exceed 1.5. Flex duct to have minimum R-value of 6.0.

B. Maximum length of flexible ductwork not to exceed 8'-0".

2.13 EQUIPMENT CONNECTIONS

A. All equipment shall be connected to ductwork with flexible duct collars.

B. Flexible connection shall be heavy glass fabric, coated with "Durolon", weighing approximately 24 oz. per sq. yard, as manufactured by Duro Dyne Corp.
   1. For ducts 30" and below use 3" free length
   2. For ducts above 30" use 5" free length.

2.14 TRIM FRAMES

A. Whenever ductwork passes through masonry, furnish and install mitered angle trim frames around ductwork to conceal rough masonry opening.

2.15 EXTERIOR DUCTWORK

A. If there is any exterior ductwork to be installed on the project, there shall be a mandatory meeting with the MC, the sheetmetal subcontractor, insulation subcontractor, the owner's representative and the engineering field representative prior to any duct being fabricated.

B. The MC shall produce a detail of how they will install the ductwork with respect to attachment to the duct supports, detail of how the duct shall penetrate a wall or roof and installation of insulation and external weather wrap.

C. All exterior ductwork shall be pressure tested prior to insulation being installed \ to a minimum of 2 in wg. A report shall be given to the owner's representative and the engineer stating that the duct had been tested, any leaks have been sealed and the duct retested to ensure no leakage.

D. All exterior ductwork over 18" shall be a minimum of 18 gauge, with a ductmate connection every 5 ft. All ductwork over 24" shall have condu-lock-internal reinforcing at every joint and at midpoint between joints. Exterior supports shall be a minimum of every 8 ft.

E. All exterior ductwork transverse connections shall be ductmate connection. TDF will not be acceptable on the exterior of the building. All longitudinal seams will be sealed.

F. There shall be no breaks in the external wrap on the ductwork. If there are any openings that need to be made (balancing, equipment, etc) the MC is fully responsible for sealing the opening immediately. If rain goes on the ductwork prior to the wrap being sealed, the MC shall be fully responsible to remove all wrap and insulation to the owner's representative and engineering field representative's satisfaction that there is no water on the insulation and provide new insulation and new external wrap per specifications.

PART 3 - EXECUTION

3.1 APPLICATION

A. Properly seam, brace, stiffen, support and render ducts mechanically air tight. Where SMACNA plates and/or the specifications indicate duct stiffeners or reinforcing angles, they shall be continuous around all four sides and interlock at corners.

B. Adjust ducts to suit local conditions, and if necessary to accomplish this, dimensions may be changed, as approved, but maintain cross sectional area. Install ductwork so as to provide maximum headroom, unless otherwise noted on the drawings.

C. In addition to having all shop joints in ductwork fabricated in accordance with the Manual, all field joints shall be sealed air tight in accordance with the duct seal schedule.

D. Where turning vanes, balancing damper or any other kind of products are installed, ductwork must be reinforced at all four sides and interlocked at corners.

3.2 FLEXIBLE DUCTWORK CONNECTIONS

A. Flexible connections shall be made with tie straps as made by Panduit; or equal. Straps shall be used to clamp both inner and outer liner to diffuser and branch ductwork. (2) straps are required at each end of flexible ductwork.

3.3 CONNECTIONS TO MISCELLANEOUS DUCT EQUIPMENT

A. All duct connections to duct coils, etc. must be made with smooth transitions in accordance with SMACNA. Duct dimensions specified upstream and downstream (net free area) must be maintained. Sizing ductwork to match miscellaneous equipment is not acceptable, unless design conditions are met.

END OF SECTION

SECTION 23 33 40

PREFABRICATED DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. See Section 233330 for submittal requirements.

1.3 WORK INCLUDED

A. Note: Work in this section shall be in accordance with applicable provisions in Section 233330 - Low Velocity Ductwork.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. Section 233330 - Low Velocity Ductwork

B. Section 233310 - Duct Hangers and Supports

C. Section 230713 - Ductwork Insulation

D. Section 230593 - Testing, Adjusting and Balancing

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect materials of this Section before, during and after installation and to protect installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

C. Delivery and Storage: Deliver all materials to the jobsite in their original unopened containers with all labels intact and legible at the time of use. Store in strict accordance with the manufacturer's recommendations.

D. Ductwork that is shop fabricated shall be delivered to the site in quantities acceptable to the storage area that the General Contractor has available.

PART 2 - PRODUCTS

2.1 SPECIALTY DUCTWORK

A. Round & Flat Oval duct shall be double wall, insulated and acoustically lined. Duct shall have a galvanized steel outer shell of spiral lock seam construction, 1" 1.5lb./ft^3 fiberglass insulation and a perforated steel acoustical liner.

B. Retaining fabric between perforated liner and insulation shall be .008" thick, 15.6 lb./ft^3 density with air permeability rate 9.2 ft^3/SF.S.

C. Duct shall be of a spiral lock seam construction with a mechanically formed seam locking indentation evenly spaced along the spiral seam. All spiral duct 8" diameter and larger shall incorporate multiple corrugations between spiral seams. Duct shall be galvanized steel that conforms to ASTM standards A653 and A924 and be in accordance with SMACNA 2005 Duct Construction Standards and shall conform to SMACNA's MECHANICAL Duct Construction Standards for +10" water gauge pressure. Connection methods shall be slip-fit with all joints being sealed by the installer during the installation process. The type of sealant used as well as the method and level of application should be in accordance with the sealant manufacturer's published installation instructions and as specified in 233330. All fittings that are either spot-welded or button punched construction are internally sealed. All transitions and divided flow fittings which convert from flat-oval to round 60" diameter or less. Provide 1" lining where indicated on drawing.

D. Schedule for gauge of galvanized steel for outer shell and inner perforated liner:

	Inner Liner Diameter Solid Spiral Wound			
	3"-14"	16"-26"	28"-36"	38"-50"
Duct Outer Pressure Shell	26 ga.	24 ga.	22 ga.	20 ga.
Spiral Wound Inner Liner Duct	26 ga.	26 ga.	26 ga.	24 ga.

2.2 DUCT CONNECTIONS

A. All double wall duct and fittings shall be provided with both an inner liner coupling and an outer pressure shell coupling for all connections.

B. Outer shell connections shall be by flanged joint. Inner liner connections shall be by slip joint couplings for duct to duct connections. Fitting liners shall be extended 2" beyond the outer shell to provide an inner liner coupling for duct to fitting connections.

2.3 HANGING SYSTEM

A. Cable hanging systems with adjustable mechanical devices shall be compliant with SMACNA MECHANICAL Duct Construction Standards Third Edition-2005, are allowed as replacement for threaded rod or strap, for both upper and lower attachments. Cable hangers may be used to suspend round and flat oval ductwork. Select hangers for the type of structure and suspension, based on load ratings, and end fixings based on deck structure. Crimps shall be factory installed. All cable hanger products shall be certified as SMACNA and UL listed. All parts (including the cable) shall be supplied, warranted and proof tested by the same manufacturer, Gripple; or equal. Follow recommended factory installation guidelines; do not exceed safe working loads.

2.4 FITTINGS

A. Fittings shall also have a galvanized steel shell, 1" fiberglass insulation and perforated steel acoustical linings. Construction of fittings shall be die stamped, gored, pleated or mitered as shown on drawing.

B. All double wall fitting ends shall come factory equipped with a double lipped, u-profile, EPDM rubber gasket. Gasket shall be classified by UL.

C. Fasten ducts and fittings together with self tapping sheetmetal screws or pressure proof pop rivets.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with manufacturer's installation instructions.

END OF SECTION

SECTION 23 34 16

CENTRIFUGAL FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of exhaust fans and all accessories.

B. Sound power ratings.

C. Product data sheets for all equipment.

D. Dimensioned shop drawings.

E. Special Note: Fans sizes may be selected for future capacities. Fan size substitutions which do not meet intended future capacities will not be accepted.

F. Provide submittal indicating maximum, minimum and design RPM for fan size.

1.3 GENERAL REQUIREMENTS

A. Provide supply, and exhaust fans to fit intended use and location as indicated on plans and/or specified.

B. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories as scheduled and/or as necessary to obtain required results and allow for proper maintenance. Motor efficiency shall comply with EISA standards.

C. Ratings based on tests made in strict accordance with current AMCA sound and performance standards including standard #210.

D. Each size fan to be supplied shall be tested in the manufacturer's laboratory under simulated installation **CONDITIONS**. Ratings based on test, not on interpolated or extrapolated calculation.

E. Submit certified performance tests by AMCA for all centrifugal fans 5,000 CFM and larger.

F. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed.

G. Guaranteed sound-power level ratings not exceeding those of design equipment.

H. All equipment statically and dynamically balanced to acceptable tolerances with all weights permanently fastened.

I. When dampers are supplied, furnish all necessary relays and devices to permit operation.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS DESCRIPTION

A. Centrifugal fan belt driven (unless otherwise noted). Fabricated from formed and curved material with continuously welded seams. Provide removable covers or access doors to allow access to internal parts. Drive frame structure constructed of heavy gauge galvanized steel.

B. Drive assembly and wheel shall be removable without disassembly of fan housing. Fan shaft shall be painted to avoid corrosion. Furnish accessory hinging kit to facilitate access to fan internal components and ductwork.

2.2 MOTORS

A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled, designed for 60 hertz operation.

B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%

C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.

D. For All Motors with Motor Starters:
1. Provide premium efficiency motor.
2. Fractional HP motors shall be equipped with internal automatic reset thermal overload switch.
3. Provide factory mounted and wired safety disconnect switch; locate in motor compartment. When disconnect will not fit in motor compartment furnish weatherproof NEMA 3R safety switch for external mounting.

E. Motors for Units With Variable Frequency Drives:
1. Motor shall be rated for inverter duty.
2. Provide motor of continuous duty, 1.15 SF, NEMA Class F insulation
3. For fractional horse motors with variable frequency applications provide permanently split capacitor or shaded pole type motor.
4. See Specification Section 238505 - Variable Frequency Drive Systems for further details.

F. ECM Motors
1. Motor to be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable.
2. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase.
3. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor.
4. Motor shall be speed controllable down to 20% of full speed (80% turndown).
5. Provide fan with the following fan speed control device (unless otherwise noted):
    a) Constant Speed Operation: Fan speed potentiometer, factory mounted and wired, for fan operation at a constant volume. Potentiometer shall be utilized for balancing.
    b) Variable Speed Operation: When scheduled with multiple airflows, a fan speed controller capable of accepting a 0-10 VDC signal from BMS, and any required transformer for powering controller to allow for variable speed operation throughout the range indicated. Contractor shall be responsible for any field wiring of components if they do not come factory mounted and wired.
6. Motor shall be a minimum of 85% efficient at all speeds.

2.3 FAN DRIVE ASSEMBLIES

A. Fan manufacturer shall furnish motors, V-belts and drives complete and ready to operate. Drives shall include the following:
1. Drives rated at 150% of motor horsepower.
2. Motors 5 HP and larger: Minimum of two belts.
3. Use only matched belt sets for multiple drives.
4. Cast iron or cast steel pulleys.
5. Provide test holes in belt guards for speed checks.
6. Provide shaft guards where shafts extend beyond belt guards.

7. Adjustable type motor pulley with 15% speed adjustment above and below rated speed.
8. Drive ratio not over 4:1 except as otherwise approved.

B. For Variable Frequency Applications:
1. Do not use belt drives
2. All variable frequency applications shall utilize direct drive fans.

2.4 FAN BEARINGS

A. Fan manufacturer shall furnish all fans with self-aligning, grease lubricated, ball or spherical roller bearings selected in accordance with rating method of Anti-Friction Bearing Manufacturers' Association, so "rating life" is not less than 50,000 "life hours" continuous operation at maximum speed and pressure for each AMCA fan class. If requested by Engineers, submit bearing selection calculations for approval.

2.5 VIBRATION ISOLATION

A. Fan manufacturer to furnish vibration isolation equipment for each piece of equipment supplied.

2.6 ROOF CURBS

A. Furnish prefabricated welded galvanized steel roof curb for all roof fans. Roof curb with rigid fiberglass insulation and wood nailer held in place by metal wrap-around. Standard height to be 12" above finished roof unless otherwise noted. Roof curbs will be fully assembled and placed onto the roof by the MC for installation by GC.

B. Bottoms of curbs to sit level on roof. Contractor is to verify any roof pitches prior to submittal. Provide pressure treated wood blocking to raise roof curb base to top of finished roof surface.

C. Roof curb to include metal liner to protect insulation (NO EXCEPTIONS!).

D. Cant strips formed into curb body. Provide raised cant for use with insulated roof decks. For fans located on rubber roof membranes raised cant is not to be supplied with curb.

E. For units with dampers furnished by fan manufacturer provide damper shelf mounted inside of curb. Alert duct sub-contractor to this condition for proper damper and duct installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.

B. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

C. Install vibration isolators in strict accordance with manufacturer's instructions.

D. Provide all necessary supporting ironwork for equipment requiring same.

E. Provide guards for all exposed belts, shafts or fan wheels.

F. Change pulley sizes as many times as necessary, as part of contract, to make systems deliver specified quantities of air.

G. Roof curb must be roofed and flashed to the top of wooden nailer to assure weather tightness.

H. Bolt fan housing to curb.

I. Install vibration isolation per manufacturer’s requirements. Bolt, provide hold down tabs over bottom isolator plate, or lag to equipment rail, floor, support steel, or other mounting location to ensure a stable, secure installation of equipment.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule indicating drawing no., room location, quantity, size, throw, direction of throw, accessories, finish, material type, color chart, etc.

B. Product data sheet for each unit indicating throw, noise criteria ratings, directional data (four-way, etc.) material, accessories, mounting details, etc.

C. Noise criteria shall conform with specified equipment performance data.

D. If requested by Engineer, provide sample of diffuser, register, grille, etc.

1.3 GENERAL REQUIREMENTS

A. Duct drawings are diagrammatic and do not provide exact locations for diffusers, registers and grilles. Contractor shall reference reflected ceiling plans or instructions by Architect for a more exact location of diffusers, etc., with respect to ceiling grid, light fixture and sprinkler etc.

B. Each manufacturer shall check noise level ratings for their equipment to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Engineer of any problems in this regard and change equipment size accordingly.

1.4 REQUIREMENTS FOR DIFFUSERS, REGISTERS AND GRILLES

A. All units and accessories shall be installed "sight-proof" where possible.

B. Borders and frames shall be of same material and color as specified for grille face.

C. Total quantity of air equally divided, or as required and/or shown, where diffusers blow in more than one direction. Provide blank off plate (finished to match unit) to match blow pattern shown on drawings.

D. Each supply register and diffuser shall be guaranteed to deliver indicated capacity and proper throw with draftless diffusion, and within acceptable noise level.

E. Limit terminal velocity at walls of room, below 25 fpm, measured 4' above floor.

F. Contractor shall provide proper duct connection to all diffusers, registers and grilles. Ductwork connections shall be as required by unit manufacturer. Connections required by Contractor include but are not limited to square/round adapter, transitions, flanges, neck rings, etc.

G. Because of intricate system designs and special performances required, all devices may not be of same make.

H. Suitable for recessed mounted unless otherwise indicated.

I. Diffusers and registers that are scheduled with integral opposed blade volume damper at neck must match unit construction and must be able to be adjusted through face, without removing unit.

J. Diffusers, registers and grilles do not require volume control dampers unless specifically indicated.

K. All exposed fasteners must be tamper proof.

L. Security Grille Face: Where indicated, provide heavy duty security type, tamper proof, secure grille face. Grille shall be 12 ga. thick cold rolled steel 1/2" sq. perforated grille. Fasteners shall be located 6" C/C around perimeter. Unit shall have white prime finish suitable for field painting. Provide A.J. Manufacturing Co.; or equal.

PART 2 - PRODUCTS

2.1 GENERAL

A. See drawings for schedule.

2.2 TRANSFER GRILLE ASSEMBLY

A. TG-1: Furnish and install where indicated on drawings, TG-1 assembly consisting of: (2) grilles, (1) fire damper and (1) duct sleeve. Each grille shall include plaster frame. Fire damper shall be 1-1/2hr, Air Balance Model #119AF; or equal. Locate as shown. Paint all visible interior surfaces flat black. Do not paint fire damper.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment specified under this section shall be installed where called for on plans and in compliance with the contract documents.

B. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.

C. Diffusers in lay-in type ceiling tiles shall be located at center of tile, squared with tile edges.

END OF SECTION

SECTION 23 57 05

PLATE AND FRAME HEAT EXCHANGER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Submit shop drawings on all heat exchangers and accessories.
B. Operating data and construction materials (i.e. tube gauges, etc.).

PART 2 - PRODUCTS

2.1 GENERAL

A. The plate and frame heat exchanger shall consist of pressed Type 304 stainless steel channel plates as to provide the required heat transfer area to meet the operating conditions specified. Each heat transfer plate shall have one piece molded nitrile gaskets. Gasketing shall have relieving grooves to prevent intermining of fluids and cause leak to flow outside of unit. Non-glued (clip-on) gasket system shall be provided.

B. Each heat transfer plate to be with herringbone corrugations to optimize heat transfer with nominal pressure losses.

C. The plate and frame heat exchanger shall be designed to perform the capacities and pressure drops as shown on the schedule. All materials in contact with fluids on hot and cold sides shall be 304 stainless steel.

D. The upper and lower carrying bars to be made of carbon steel with zinc yellow chromate finish to facilitate movement of the plates, and align channel plates during assembly for proper gasket seating and leak free operation.

E. The heat exchanger shall not use welded frame assembly. Entire frame shall be bolted together to allow unit to be field assembled to permit rigging into place.

F. All steel surfaces shall be thoroughly cleaned and prepared for painting. Painting over mill scale is not acceptable. All steel components shall be epoxy coated.

G. The complete assembly to be factory assembled and tested in accordance with the ASME Code, Section VIII, Division I, and furnished with ASME Code and Stamp, certification (D1 Form), for a design pressure of 150 psig for both circuits. Provide aluminum OSHA shroud around plate pack.

H. Unit(s) within the scope of AHRI Standard 400 shall be certified and list the manufacturer's AHRI part number for liquid to liquid heat exchanger. Unit(s) outside the scope of AHRI Standard 400 shall be designed according to the standard and list the manufacturer's AHRI part number, surface area, and corresponding heat transfer coefficient.

I. Unit(s) within the scope of AHRI Standard 400 shall be certified and list the manufacturer's AHRI part number for liquid to liquid heat exchanger. Unit(s) outside the scope of AHRI Standard 400 shall be designed according to the standard and list the manufacturer's AHRI part number, surface area, and corresponding heat transfer coefficient.

PART 3 – EXECUTION

3.1 GENERAL

A. Installation shall be in strict accordance with manufacturer's instructions.

B. Support independent of piping.

C. Provide 4" high concrete housekeeping pad.

END OF SECTION

SECTION 23 73 13

CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of units and accessories.

B. Unit capacities, ratings, weights, etc.

C. Dimensional shop drawings for units and accessories.

D. Sound power data.

E. Motor ratings. Motor efficiency shall comply to EISA standards.

F. Operation and maintenance manuals.

G. If unit is a substitution, provide 3/8"=1'-0" scale drawing with submittal indicating unit, coil removal, service area and surrounding ductwork and piping to prove substitute unit fits into intended space.

1.3 GENERAL REQUIREMENTS

A. Central station equipment and accessories shall be factory tested and certified by Air Conditioning and Refrigerant Institute (ARI). Units ratings shall comply with ARI 430 standards.

B. Units shall be factory assembled complete, and be ready to operate with all required and listed components necessary for proper operation.

C. Provide fan and motor drive assemblies with required accessories.

D. Units shall include internal vibration isolation. For units specified without internal vibration isolation, contractor shall furnish and install external isolators and related hardware.

PART 2 - PRODUCTS

2.1 DESCRIPTIONS

A. Casing: Casing shall be formed and reinforced galvanized steel panels fabricated to allow access to internal components. All joints in casings shall be fully sealed and bolted connections. Casings and joints shall be stiffened and reinforced to meet pressure requirements scheduled.
   1. Provide double wall construction with perforated inner liner.
   2. Component modules shall be sectionalized removable panels. Filter sections shall have access doors with latch type handles.
   3. Condensate drain pans shall have double wall construction with drain connections on both ends. Condensate pan to be insulated with 5/8" thick foam faced with aluminum foil vapor barrier, all to meet NFPA-90A Code requirements.
   4. Insulation: All sections shall be insulated with 2" thick, 3 lb. density neoprene-coated fiberglass, secured to casing with waterproof adhesive and permanent mechanical fasteners. Insulation shall meet NFPA-90A Code requirement.

B. Fan Section: Fans shall be double width double inlet with forward curved blades. Fan shafts shall be solid steel. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed and shall be statically and dynamically balanced.
   1. Fan bearings shall be self-aligned, pillow block regreasable ball type for an average 200,000 hours at design operation conditions. Extend grease lines from internal lubrication points to outside of fan section to facilitate re-greasing.
   2. Vibration isolation of the entire fan, motor and drive assembly to be by 2" deflection springs, internally mounted at factory, together with fan discharge flexible connection and thrust restraint springs.
   3. Fan motors and drives shall be factory mounted inside fan section casing. Belt drives shall be variable pitch. Drive design shall provide 1.4 service factor. Fan motors shall be premium efficiency to meet or exceed 1) New York State Energy Code, and 2) Qualify for local utility rebate program.
   4. For Units With Variable Frequency Drives: Provide motor of continuous duty, 1.15 SF, NEMA Class F insulation, ball bearings, cast iron frame and end shield. Provide thermal overload in motor windings and switch. Motor shall be provided by Reliance Electric or unit manufacturer. See Specification Section 238505 - Variable Frequency Drive Systems for further details.
   5. Provide extended condensate pan under fan housing on all air handlers without down blast.

C. Cooling Coil Sections:
   1. Refrigerant coils shall be aluminum plate fins with belled collars bonded to 1/2" minimum OD copper tubes by mechanical expansion. Galvanized steel casings and steel headers with threaded connections. WP 300 psig at 200°F. Coils shall be drainable, no turbulence promoting devices, headers shall have drain and vent connections.
   2. On refrigerant coils furnish thermal expansion valve(s) (TXV), nozzles and liquid line solenoid valves (LLS). Liquid solenoid valves shall be compatible with controls provided with condenser units.

D. Heating Coil Sections:

1. Hot water heating coils shall be aluminum plate fins with belled collars bonded to 1/2" minimum OD copper tubes by mechanical expansion. Galvanized steel casings and steel headers with threaded connections. WP 300 psig, at 200°F. Coils shall be drainable, no turbulence promoting devices, headers shall have drain and vent connections.

E. Mixing Box Sections: Mixing boxes shall have parallel blade, interconnected outside air and return air dampers. Damper blades shall have parallel bends and shall be welded to 1/2" diameter steel rods, rotating in nylon bushings and mounted on rigid steel frames. Furnish low leakage damper blades. Filters shall be located in mixing box unless otherwise indicated.

F. Filters & Racks: Casings shall have latching type access doors on both sides of unit. Filter holding frames shall be angle type for 2" thick disposable filter located in filter mixing box unless otherwise indicated.

1. Standard filters unless noted otherwise shall be disposable type, 2" thick with pleated fibrous filter media, encased in fiber board cell, with perforated metal support on each face.

G. Controls: Controls by Temperature Control Contractor. See Specification Sections 230993 for details.

2.2 MOTORS

A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled.

B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%

C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.

D. Motors controlled by Variable Frequency Drive (VFD) units shall be rated for inverter duty (NEMA MG1, Part 31).

PART 3 - EXECUTION

3.1 GENERAL

A. Install all equipment in strict accordance with manufacturer's instructions.

B. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

C. Provide one (1) complete spare set of filters for each unit. After building is complete and is fully occupied contractor shall remove and dispose of construction filter set and install new set.

D. Provide flexible duct collars to SA, RA and OA connections.

E. On units without internal vibration isolation, provide external spring isolators.

F. Provide all secondary steel necessary to mount units.

G. Floor mounted units shall be set on 4" concrete housekeeping pads.

H. Lubricate bearings, pulleys, and other moving parts, with factory recommended lubricants.

I. Contractor is responsible for coordinating piping and motor locations (i.e. - L.H. or R.H.) to match drawings and/or actual job site conditions.

END OF SECTION

SECTION 23 74 50

ROOF EQUIPMENT SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Dimensioned Schedule of all equipment
B. Shop drawings on all equipment and accessories specified hereinafter.
C. Product data cut sheets for each item supplied.

1.3 GENERAL REQUIREMENTS

A. Provide roof mounted supports to fit intended use and location as indicated on plans and/or specified.

B. Quantity, size and arrangement, as necessary to obtain required results and allow for proper support.

C. Contractor shall verify actual equipment dimensions and supports and adjust dimensions accordingly for actual equipment supplied.

D. Rails and pedestals are to be used to support exterior equipment ductwork, and/or piping.

E. Rails must be mounted perpendicular to joists, with an 8" overhang on each end.

PART 2 - PRODUCTS

2.1 ROOF EQUIPMENT SUPPORT RAILS (RESR)

A. This contractor shall furnish prefabricated 18 gauge welded galvanized steel rail with integral base plate. Size to be 12" larger than unit that it supports or a minimum of 8" overhang each end over joist (whichever dimension is larger). This contractor shall verify actual length dimensions required. This Contractor shall provide pressure treated top rail/wood blocking and metal cap flashing of sufficient width and length to cover insulation. Insulation, flashing, roof membrane, cap flashing and sealants shall be installed on rail by General Contractor. Rail to be Model ER-2B; RPS Corporation.

B. Rail Slope Roof: Where required, for sloped roof structures, provide uneven rail dimensions to maintain top rail's level.

C. Rail Installation: This Contractor shall furnish rail units and turn over to GC for installation.

D. Vibration isolation and Pads: To be provided with rails for each piece of equipment.

2.2 ROOF EQUIPMENT SUPPORT RAILS – REFRIGERANT PIPING

A. This contractor shall furnish prefabricated reinforced PVC base that shall accommodate a uni-strut rail to be mounted on top. Each pipe will then be fastened directly to the uni-strut. Provide support rail every 6ft. Unit shall not be flashed into the roof. Rail to be Pedestal Plus with U-Channel strut; RPS Corporation

2.3 ROOF EQUIPMENT FRAME (REF)

A. This contractor shall furnish prefabricated equipment frame which shall consist of (4) rubber bases and interlocking Unistrut rails that can support 500lbs for each roof mounted condensing unit. Unit to be assembled on site. Model number RTSEQ-MDF, Eberl Iron works; or approved equal.

2.4 DUCT MOUNTING PEDESTAL (DMP-1)

A. This contractor shall furnish prefabricated Duct Mounting Pedestals. Each shall include an equipment rail 12" longer than the duct width (minimum rail length for any duct shall be 18"-0") with a single galvanized steel slide channel equal in length to the equipment rail attached to galvanized steel "U" shaped mounting brackets secured to the side of the equipment rail with lag bolts. This Contractor shall verify actual dimensions required. The duct mounting slide assembly shall be sized to suit the duct supported and fabricated of galvanized steel and shall have galvanized 18" long continuous threaded rods to allow 12" vertical adjustment, and lateral adjust spacer bracket for 12" horizontal adjustment. Furnish rail with fully mitered 3" cant. This Contractor shall furnish rigid polyisocyanutare insulation (minimum R-25) to cover rail perimeter. This Contractor shall provide pressure treated top rail/wood blocking and metal cap flashing of sufficient width and length to cover insulation. Duct supports and duct flashing provided and installed by this contractor. Insulation ,flashing, roof membrane, cap flashing and sealants shall be installed on rail by General Contractor. Furnish duct mounting pedestals with ER-4B rails by RPS Duct Mounting Pedestals as manufactured by Roof Products & Systems Corporation; or approved equal.

B. Rail Installation: This Contractor shall furnish rail units and turn over to GC for installation.

2.5 DUCT MOUNTING PEDESTAL (DMP-2)

A. Furnish and install polycarbonate rooftop pipe support system, maximum uniform load of 300 lbs per duct, Unistrut Model 8-DS-P; or approved equal.

B. Description:
1. "U" shaped cradle situated in a polycarbonate resin seat.

2. Self-lubricating roller polycarbonate resin rod and roller. As daytime temperatures warm the roof membrane and the mechanical pipe network found on the roof, causing them to expand, the roller bearing in the pipe stand rolls beneath the pipe it supports. A difference between night and day temperatures of 20°F. causes 100 ft. of 1" steel pipe to move as much as 1/4".
3. A strut system constructed of hot-dipped galvanized steel components including clevis hangers or band hangers.
4. For the duct supports, the ducts rest on a 1-5/8" x 1-5/8" or 1-5/8" x 7/8" Unistrut channel and are adjustable in height.

C. Installation Process:
1. Center the support beneath the pipes or ducts so that the pipe or ducts are squarely over the pipe stand.
2. For adjustable models, adjust the support to the desired height and to ensure a uniform load with other supports. Make certain the horizontal support strut is level.
3. Place the pipe or duct on the support without dropping or causing undue impact.
4. For heavier loads install an additional sheet of roofing material, a Unipier Deck Plate, or Unipier Support Pad beneath the duct support.
5. For built-up roofs, all loose aggregate from an area 2" larger than each base should be removed from the area directly beneath the support. Care should be taken to install each support so it supports a proportional and equal amount of weight at each support.

D. Loads and Spacing: Spacing not to exceed 10' between centers depending upon the load. Make certain each pipe stand is properly elevated to ensure a uniform load weight at all pipe stands and not exceed the load specified for the particular model support.

2.6 PIPE SUPPORTS (PEDESTALS)

A. Pipe mounting pedestals shall each include an RPS equipment rail 24" long for single pipe support, with a single 24" long galvanized steel slide channel attached to galvanized steel U-shaped mounting brackets secured to the side of the equipment rail with lag bolts. The 2", 4", or 6" pipe roller assembly shall be sized to suit the pipe supported and shall have galvanized 18" long continuous threaded rods to allow 12" vertical adjustment, galvanized removable pipe retainer bracket, cast iron pipe roller, and lateral adjust spacer bracket for 12" horizontal adjustment.

2.7 PIPE PENETRATIONS

A. Each pipe portal shall include an RPS insulated, prefabricated roof curb, a laminated acrylic coated ABS plastic cover with pre-punched mounting holes and molded sealing ring on the collared opening, and an EPDM compression molded rubber cap. PROVIDE RC-2A STYLE 11" IN HEIGHT. Use N28 cap for up to (2) 3/8" through 1" pipes and for up to (2) 1" through 2" pipes; use N18 cap for up to (4) 3/8" through 1" pipes; use N21 cap for up to (4) 1" through 2" pipes; use N62 cap for (1) 2" through 6" pipe; and use N182 cap for (1) 8" through 12" pipe. Each EPDM rubber cap shall include one stainless steel snaplock swivel clamp per nipple.

2.8 ROOF EQUIPMENT PIPE PORTAL (REPP)

A. Pipe Portal System:
   1. Roof Curb Assembly: Size and height as scheduled. Galvanized steel 18 gauge assembly welded corner seams and base flange, insulated with 1-1/2" thickness 3 lb. rigid fiberglass board, factory installed continuous wood nailer.
   2. Curb Cover: Size and arrangement as scheduled. Acrylic coated ABS rib reinforces plastic cover pre-punched with mounting and weathertight sealing ring, service temperature range -40°F to 160°F with a high resistance to ozone and UV rays.
   3. Protective Caps: Size and arrangement as scheduled. Compression molded EPDM rubber with a service temperature range of -60°F to 250°F with a high resistance to ozone with multiple steps for weathertight seal for various size pipe penetrations.
   4. Furnish stainless steel snap lock swivel clamps for each opening cone to tightly seal each penetration.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate exact mounting locations with structural drawings.

B. Rails and pedestals are to be provided by this Contractor, installation by the GC, including wood blocking where indicated.

C. Install roof support equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.

D. Contractor shall coordinate all roof locations and opening sizes, as required.

E. Unless noted otherwise - roof equipment supports shall be flashed by others; roofing modifications do accept equipment supports shall be preformed by others.

END OF SECTION

SECTION 23 74 55

ROOF CURBS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Submit shop drawings on all roof curbs and accessories specified hereinafter.

B. Operating and maintenance instruction manuals and parts list.

1.3 GENERAL REQUIREMENTS

A. Provide roof curbs to fit intended use and location as indicated on plans and/or specified.

B. Capacity, size and arrangement, as necessary to obtain required results and allow for proper maintenance.

C. All curbs to be insulated.

D. NOTE: The minimum height from the top of the curb to the top of the finished roof shall be 12". This contractor shall provide additional blocking as required to accommodate this.

PART 2 - PRODUCTS

2.1 ROOF CURB FOR FLAT ROOF

A. Furnish prefabricated 18 gauge welded galvanized steel curb, as noted above. Furnish curb with 1-1/2" thick, 3 lb. density rigid insulation, 2 x 2 treated wood nailer, and reinforcing as required.

B. Furnish fully mitered 3" cant and variable step to match deck insulation thickness.

C. Furnish standard height of 12" above finish roof surface.

D. Furnish series A, Model #TC-1, as manufactured by Thycurb Corp.; or an approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof curbs in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.

B. Contractor shall coordinate all roof opening sizes and locations, as required.

C. Provide all necessary supporting ironwork for equipment requiring same.

D. Roof curb must be roofed and flashed to the top of wooden nailer to assure weather tightness.

E. Provide damper shelf to support back draft damper inside curb.

END OF SECTION

SECTION 23 75 00

ROOFTOP UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Submit shop drawings of units with all accessories as specified in this section. Shop drawings shall include schedule of units including ratings of fan and coils. Sound power levels shall be submitted. Submit (3) copies of installation, operation and maintenance manuals.

B. Submittals shall be marked to show specified information.

1.3 GENERAL REQUIREMENTS

A. Provide outdoor, roof curb mounted, packaged air conditioning units to fit intended use and location as indicated on Plans and/or specified:

B. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories as scheduled and/or as necessary to obtain required results and allow for proper maintenance. Ratings based on Standard Test Code for Centrifugal Fans, adopted jointly AMCA and ASHRAE. Each size fan to be supplied shall be tested in the manufacturer's laboratory under simulated installation conditions. Ratings based on test, not on interpolated or extrapolated calculation. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed. Guaranteed sound-power level ratings not exceeding those of design equipment. All equipment statically and dynamically balanced to acceptable tolerances with all weights permanently fastened. Fan bearings shall be rated for 200,000 hour life continuous operation at maximum speed and pressure in accordance with ANSI Code B3.15.

C. Equipment shall include motors, belt drives, belts, and required accessories; horsepower as scheduled. Motor efficiency shall comply with EISA standards.

D. Equipment manufacturer shall furnish vibration isolators for each piece of unit as required; spring type or unit fully internally isolated with thrust restraint springs, flexible connections and deflection springs.

PART 2 - PRODUCTS

2.1 PRODUCT DESCRIPTION

A. Roof Curb:
1. Where scheduled furnish prefabricated, 12 ga. galvanized roof curb height above insulation 12": to be supplied by unit manufacturer.

B. Unit Casing:
1. Unit shall to be furnished with insulated discharge plenum.
2. Unit shall be completely insulated with 2" thick neoprene coated glass fiber secured to side, top and end panels with adhesive and mechanical fasteners. Lifting brackets with lifting holes shall be provided on the unit base to accept cable or chain hooks.
3. Filters shall be 2" thick, removable throwaway filters.
4. Where roof curb scheduled; unit frame and base shall be 14 ga. galvanized steel. Unit to have formed recess that seats on roof curb gasket to provide watertight seal.
5. Where roof curb not required provide weatherproof sheet metal bottom pan with full thickness insulation.

C. Supply Fan:
1. Supply fan shall be centrifugal, forward curve, statically and dynamically balanced for quiet operation. Fan motor shall be heavy duty, open drip proof with re-lubricative ball bearings.
2. Furnish fan assembly with vibration isolated floating frame.

D. Heating Coil Sections:
1. Hot water heating coils shall be aluminum plate fins with belled collars bonded to 1/2" minimum OD copper tubes by mechanical expansion. Galvanized steel casings and steel headers with threaded connections. WP 300 psig, at 200°F. Coils shall be drainable, no turbulence promoting devices, headers shall have drain and vent connections.

E. Compressor:
1. Shall be heavy duty, scroll type, semi-hermetic type with reversible, positive displacement oil pump, and overload protection. Each compressor shall have a complete refrigeration circuit including, sightglass, filter drier, manual shutoff valve and relief valve. Compressor shall be mounted on vibration isolation blocks.

F. Cooling System:
1. Cooling Coil shall be seamless copper tubing, mechanically bonded to corrugated aluminum fins. Coils shall be factory leak tested. Furnish with factory mounted expansion valves. Cooling coils shall be circuited for combination row/face split.
2. Drain Pan with a mastic coating shall be provided with the cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall be connected to a threaded drain connection extended through the unit base. Units shall be provided with a

secondary mastic coated drain pan connected to the primary drain pan.

3. Furnished cooling system complete with refrigeration controls. Where scheduled furnish optional unloading steps complete with suction switches and step controller. The refrigeration controls shall include expansion valve, safety hi/low pressure switches and anti cycling timer.

G. Relief Type:

1. Gravity relief system (where scheduled) shall include exhaust air damper 0-100% rated SA located in the return air section to relieve air out the back of the unit. Exhaust dampers shall be sealed with urethane gasketing on the contact edge. Exhaust louvers and bird screen shall be provided.
2. Powered relief (where scheduled) shall include powered relief exhaust air fan, sized for 100% relief, with a relief air damper. Fan shall be controlled with an integral VFD factory wired speed controller.

H. Electrical Power Requirements:

1. Weatherproof safety disconnect switch with external lever shall be provided by unit manufacturer.
2. Unit shall be equipped with a single point connection. All internal motors sub feeds shall have individual overcurrent protection housed in an electrical enclosure which shall include terminal blocks for all field connections.
3. All motors shall include integral motor starter or variable frequency drive as indicated and shall be factory mounted and wired.

I. Controls: Controls by Temperature Control Contractor. See Specification Sections 230993 for details.

2.2 MOTORS

A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled.

B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%

C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.

D. Motors controlled by Variable Frequency Drive (VFD) units shall be rated for inverter duty (NEMA MG1, Part 31).

PART 3 -EXECUTION

3.1 GENERAL

A. Install in strict accordance with manufacturer's instructions.

B. Duct connection to units shall have flexible connections.

C. Furnish (1) spare set of filters for each unit.

D. This Contractor is responsible to furnish and install condensate trap and drain external to unit; drain shall discharge to roof.

E. Roof curbs to be fully assembled and placed onto roof by HC, for installation GC.

END OF SECTION

SECTION 23 75 10

VARIABLE REFRIGERANT FLOW SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Shop drawings shall include certified manufacturer's dimensioned drawings for each chassis size specified including required clearances. Submit rated unit capacities, operating weights and accessories on all equipment in this section.

B. Submit parts list, operating, maintenance and installation instructions including unit support requirements.

C. Submittals shall be marked to identify specified information.

1.3 WORK SPECIFIED ELSEWHERE

A. 232300 - Refrigerant Piping & Specialties

B. 230993 - Temperature Controls

1.4 SPECIAL CONDITIONS

A. All equipment shall be by a single manufacturer. Equipment manufactured by multiple companies and packaged will not be accepted.

B. Supplier of equipment shall have established a service department, staffed by factory trained personnel, located within 180 miles of the project, which has been in continuous operation for the past (5) years.

1.5 GENERAL REQUIREMENTS

A. Furnish all labor, materials, equipment and services necessary for and incidental to the installation of all equipment as shown on the drawings and specified hereinafter. Unit supplier shall locally maintain factory trained technicians capable of servicing supplied units.

B. All equipment furnished shall be rated in accordance with ARI Standard 320 and shall be UL listed and labeled. Scheduled capacities and efficiencies are considered the minimum acceptable.

C. Motor efficiency shall comply with EISA standards.

D. Start up and Commissioning Requirements: The system must be started up and commissioned by a factory trained technician.

E. Quality Assurance:
1. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
2. All wiring shall be in accordance with the National Electric Code (NEC).
3. The system will bear the Energy Star label.
4. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

PART 2 - PRODUCTS

2.1 GENERAL

A. System Description:
1. The variable capacity, heat recovery air conditioning system shall be a variable refrigerant volume series (simultaneous heat/cool model) split system. The system shall consist of multiple evaporators using PID control, and VRV® outdoor unit. The outdoor unit shall have capacity as scheduled and include, direct expansion (DX), air-cooled heat recovery air-conditioning system. Variable speed driven compressor multi-zone spilt system. All indoor units are each capable of operating separately with individual temperature control.
2. The outdoor unit shall be interconnected to indoor units. The indoor units shall be connected to the outdoor utilizing REFNET specified piping joints and headers.
3. Refrigerant: the system shall use type R410A refrigerant

B. Warranty: The units shall have a manufacturer's warranty for a period of (1) year from date of installation. The units shall have a limited labor warranty for a period of (1) year from date of installation. The compressors shall have a warranty of (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of the manufacturer.

C. Operating Range: The operating range shall be as follows:
1. Cooling (°F): 23°F DB to 115°F DB (approximate)
2. Heating (°F): -3.5°F DB to 64°F DB, -5°F WB to 60°F WB

2.2 OUTDOOR UNIT DESCRIPTIONS

A. General: The outdoor unit is designed specifically for use with VRV series components.
1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a Daikin scroll compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receivers and accumulators.
2. The outdoor unit can be wired and piped with unit access from left, right, rear or bottom.

3. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.
4. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
5. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature. Oil recovery cycle shall be automatic occurring 1 hour after start of operation and then every 6 hours of operation.
6. The outdoor unit shall be capable of heating operation at minimum dry bulb ambient temperature (see general section for parameters) without additional low ambient controls.

B. Unit Cabinet: The outdoor unit model shall be completely weather proof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Condensing Fan:
1. The condensing unit shall consist of propeller type, direct-drive fan with 750 W motors.
2. The condensing unit fan motor shall have multiple speed operation via DC inverter, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG with available by field setting switch to a maximum 0.24 in. WG pressure.
3. The fan shall be a vertical discharge configuration with an air flow of 7,400 cfm.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. Condenser Coil:
1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchanger, rifled bore tube design to ensure highly efficient performance.
3. The coils shall be complete with corrosion treatment of an acrylic resin type. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:
1. Each module shall include (2) scroll type compressors; (1) with inverter drive and (1) with a non-inverter drive.
2. The capacity control range shall be 14% to 100%, with 29 individual capacity steps.

3. The inverter driven compressor shall be variable speed controlled (PAM inverter) which is capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.
4. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC, hermetically sealed scroll type with a maximum speed of 6,480 rpm.
5. Both types of compressors shall be of the hermetically sealed scroll type.
6. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
7. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
8. Oil separators shall be standard with the equipment together with an oil balancing circuit.
9. The compressor shall be mounted to avoid the transmission of vibration.

2.3 REFRIGERANT NETWORK JOINT KIT DESCRIPTION

A. Factory assembled refrigerant network joint fittings for refrigerant branch connections of VRV units.

B. Fittings shall be configured as listed below:
1. Heat Pump Service: (1) gas side; (1) liquid side.
2. Heat Recovery Service: (1) suction gas side; (1) discharge gas side; (1) liquid side.

C. Fittings shall have multiple tube sizes for ease of field installation. Installer can field trim joint assembly to obtain actual refrigerant pipe size required for system.

D. Joint kits are intended for use with deoxidized phosphorous seamless copper pipe.

E. Fittings assemblies shall all include a pre-molded insulation cover at fitting joint location.

F. Joint kit shall be supplied with factory issued tool kit. Tool kit to include R410-A refrigerant pressure gauges; flare fitting tool and tubing cutter tool.

2.4 REFRIGERANT PIPING

A. Piping Materials: See Section 232300 - Refrigerant Piping & Specialties, for work requirements.

B. Exception: For VRF systems, modify the following material listing from Section 232300 as listed below:
1. 5/8" and below: Type K Seamless Soft Temp ACR Copper Tube
2. 7/8" and above: Type L Hard Drawn ACR Copper Tube

C. Piping Maximum Lengths: The system shall be capable of refrigerant piping up to 410 equivalent feet, a total combined length of 1000 feet of piping between the condensing and fan coil units with 165 feet maximum vertical difference, without any oil traps or additional equipment. In case where the outdoor unit is located below the indoor unit, the vertical difference is a maximum of 133 feet.

D. Insulation: Both liquid and suction lines must be individually insulated between the outdoor and indoor units with Armaflex type insulation.

E. Nitrogen Purge: All VRF refrigerant tubing shall be purged with nitrogen to clean out foreign material prior to vacuum evacuation process.

2.5 UNIT CONTROLS DESCRIPTION

A. Wiring Requirements:
1. The control voltage between the indoor and outdoor unit shall be 16 VDC non-shielded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.
3. Wire Type: 2 wire, non-polarity, non-shielded. The control wiring lengths are:

Wire Run	Control Wiring Length (max.)
Outdoor to Indoor Unit	6,665
Outdoor to Central Controller	3,330
Indoor Unit to Remote Control	1,665

4. Wiring accessible concealed spaces can be run as open wiring, see Section 230995.
5. Wiring for VRV systems can be installed with refrigerant piping runs, enclosed inside thermal insulation as per manufacturer's recommendations.
6. Wiring diagrams and Sequence of Control including I/O Listing can be found in specification 230993 and Contract Drawing M-700s.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment shall be installed in strict compliance with manufacturer's instructions.

B. Install units level and firmly anchored in indicated locations.

C. Furnish wiring diagrams to Electrical installer for power wiring to units.

D. Start-Up Services:
1. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished.
2. Factory alignment, lubrication, motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

E. Control System Configuration: Contractor shall obtain the services of a factory trained technician to setup and configure all controls for the project. Configuration shall include setup of program parameters for weekly occupied/unoccupied schedules and all timed events; and shall also include programming all other parameters, i.e. all temperature setpoints.

F. VRV Configuration Parameters: Contractor shall have factory trained start up technician configure the following special parameters for the project in all noted spaces.

G. Office/Administrative Spaces:

Function	Settings
On/Off Button	Enable
Room Temperature Display	Allowed
Setpoint Temperature Display	Turn On
Room Setpoint Adjustment	Enable
Setpoint Adjustment Bias	Allow 2°F / 2°F Bias
Fan speed Switch	Set to automatic - disable manual function
Operation Mode Selector Button	Disable

H. Class Room Spaces:

Function	Settings
On/Off Button	Disable
Room Temperature Display	Allowed
Setpoint Temperature Display	Turn Off
Room Setpoint Adjustment	Disable Note: input fixed setpoint temperature
Setpoint Adjustment Bias	Allow +1.5°F / -1.5°F Bias
Fan speed Switch	Set to automatic - disable manual function
Operation Mode Selector Button	Disable

END OF SECTION

SECTION 23 81 13

PACKAGED TERMINAL AIR CONDITIONER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Submit shop drawings on equipment specified hereinafter.
B. Submit performance data, operating and maintenance instruction manuals, parts list and installation instructions.
C. Submit color chart, outdoor louver, finishes available.
D. Submittals shall be marked to identify specified information.

1.3 GENERAL REQUIREMENTS

A. Provide units of size, capacity, construction, speed, service and location as shown on drawings and specified hereinafter. Motor efficiency shall comply with EISA standards.

PART 2 - PRODUCTS

2.1 PACKAGED TERMINAL AIR CONDITIONER

A. Cabinet discharge grille shall be continuous bar-stock type. Unit controls shall be concealed under control access door, exposed knobs will not be accepted. Long cabinet shall be soft beige enamel: Removable decorator front panel shall be fabricated of 18 ga. steel. Provide wall guard flange to conceal joint between wall and sleeve wall.

B. Wall sleeve shall be 18 ga. galvanized steel, factory coated with ACRYGLAS corrosion resistant finish. Wall sleeve shall be dry: all condensate and rainwater must be contained in chassis sump. Provide wall sleeve extension for wall thicker than 14".

C. Exterior louver shall be clear anodized extruded aluminum. Louvers are to be factory mounted in wall sleeve.

D. Chassis shall consist of compressor, condenser fan and coil, twin evaporator fans and coil, and unit controls. The unit shall be completely assembled and factory tested prior to shipment and shall be designed to be easily removable from the wall sleeve for service. Compressor shall be hermetically-sealed permanent split capacitor type with thermal overload; vibration isolation internal and external. Refrigerant control device shall permit operation to 40°F outdoor ambient temperature. Condenser fan motor shall be separate from evaporator fan motor. Condenser and evaporator coils shall be constructed of seamless copper tubes with aluminum fins. Evaporator fans shall be forward-curved centrifugal type, direct connected to 2 speed motor with 1075 rpm maximum at high speed.

E. Evaporator coil drain pan shall be cleanable without removing chassis from wall sleeve. All condensate is re-evaporated on condenser coil so that no drains are required. Sheetmetal parts shall be unpainted galvanized. The chassis shall contain a water sump for water collection. It also shall be furnished with a motorized damper with concealed damper override switch.

F. Units shall include throw-away filters. Provide (1) extra set.

G. Hot water coil shall be one row deep with copper tubes and aluminum fins and shall be controlled by motorized, 2 way, 2 position valve. This valve shall be normally open.

H. Electrical stub-up and coil supply and return piping shall enter bottom of machine (in sub-base).

I. Unit control panel shall include "Hi-Lo" fan speed pushbuttons. Room thermostat shall be unit mounted, with manual changeover from heating to cooling. Pushbuttons will be marked "Off-Heat-Cool". Room-side fans shall run continuously except when the unit is turned off. A setback thermostat shall be mounted and wired in unit prior to shipment. Setback shall be activated by "Unoccupied" pushbutton.

2.2 SUB-BASE

A. Unit shall be provided with welded, reinforced sub-base (where required) capable of supporting entire unit weight. Sub-base shall be adjustable to compensate for varying wall thickness', and shall have leveling bolts. Factory mount electrical junction box and receptacle for permanent connection of unit. Height to be field verified for louver to fall in block coursing.

PART 3 - EXECUTION

3.1 GENERAL

A. Install unit in strict accordance with manufacturer's instructions.

B. Isolate units with ball valves to permit servicing of control valves, etc.

C. Contractor responsible for correct end connections and coil arrangements, with respect to installation of control valves, etc.

D. Provide manual air vent on return end of each heating unit on upfeed hot water installations.

E. All enclosures fastened to structure with screws, bolts, etc.; no nailing allowed.

F. Provide manufacturer's louver unless otherwise noted.

G. Louver installed by this contractor, GC to provide opening.

H. Contractor shall seal any openings water tight around wall box and louver.

I. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

END OF SECTION

SECTION 23 81 15

AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Submit performance data on all equipment in this section, shop drawings, description of all accessories, installation, operating and maintenance manuals.
B. Submittals shall be marked to identify specified information.
C. Submit wiring diagram indicating all field connections and internal controls and logic.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The condenser unit and evaporator coil of the air conditioning unit shall be matched per ARI Standards and the entire system shall meet or exceed minimum energy efficiency rating as scheduled below.

B. All condenser units shall be selected based on an entering ambient air temperature of 95°F and an air temperature of 80°Fdb/67°Fwb entering the evaporator coil.

C. Provide condenser unit to fit intended use and location as indicated on plans.

D. Motor efficiency shall comply with EISA standards.

2.2 CONDENSER UNIT

A. Condenser coil shall be of nonferrous construction with aluminum plate fins mechanically bonded to seamless copper tube.

B. Condenser fans shall be direct drive, propeller type for vertical discharge. Fan motors shall include permanently lubricated bearings, thermal protection, resilient mountings. Each fan shall include safety guard.

C. Compressors shall be hermetic type, with external spring isolators, capacity control, automatically reversible oil pump, and crankcase heater.

D. Furnish rubber and shear vibration isolation mounting.

E. Furnish all necessary accessories as specified herein and as shown on drawings, including: isolation valves, thermal expansion valve, nozzles and liquid solenoid valves. Refer to Specification Section 232300 - Refrigeration Piping and Specialties.

F. Provide internal vibration isolation.

G. Casing shall be weatherproof unit suitable for outdoor installation, and shall be galvanized steel, zinc phosphatized and finished with baked enamel. Provide removable access panels at all locations requiring servicing.

H. Factory Controls: Controls shall be factory mounted and wired. Furnish the following:
1. High/low pressure switches
2. Compressor overload protection
3. Time delay to prevent short cycling of compressor
4. Low ambient control
5. Winter start package
6. Motor master control package
7. Relay package including 24 Volt transformer and terminal block ready to accept field installed control wiring.

I. Low ambient cut-out to lock out compressor unit below 50°F (adjustable). Equipment supplier shall install and wire lock-out controls.

J. Hot Gas Bypass: Manufacturer shall furnish and install a hot gas bypass valve, complete with accessories, for all units. Valve shall have an integral solenoid valve and a pilot assembly with an adjustable range. Hot gas bypass shall be factory installed within the unit. Install hot gas bypass to the suction line. Locate the not gas bypass valve close to the compressor. Install a short (as possible), bypass valve-to-discharge line connection. The hot gas bypass line shall be fully insulated.

K. Low Ambient Controls: Provide accessory kit to allow condenser to operate at low outside air conditions. Unit shall operate as head pressure control by modulating condenser fan speed at low OAT. After fan shutdown refrigerant circuit continues to operate. Controller shall be solid state, with integral transformer and remote temperature sensors. Adjustable cut out speed and hand start mode.

PART 3 - EXECUTION

3.1 GENERAL

A. Locate condenser to allow sufficient space for air flow and servicing space requirements.

B. Install unit in strict accordance with manufacturer's instructions.

C. Field services shall be provided by a factory trained representative to fully set-up and adjust the condensers, after the installations have been completed and before the condensing units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before condensing units are placed in service.

D. Refer to specification Section 232300 - Refrigeration Piping and Specialties; for refrigerant piping systems.

E. Release and adjust compressor hold down bolts before starting unit.

F. After installation is complete, and just prior to completion of project, Contractor shall clean condenser coils, by an approved method, to remove dirt and debris which may have accumulated during construction.

G. Provide wind baffles as recommended by manufacturer.

END OF SECTION

SECTION 23 81 26

DUCTLESS SPLIT SYSTEM COOLING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Submit performance data on all equipment in this section, shop drawings, description of all accessories, installation, operating and maintenance manuals.
B. Submittals shall be marked to identify specified information.

PART 2 - PRODUCTS

2.1 FAN COIL UNIT

A. Fan coil to include microprocessor controls, wired remote, anti frost control, adjustable air louvers, 3 speed fan motor, cleanable filters, internal condensate pump and low ambient temperature controls.

B. See section 230933 - Temperature Controls, for additional controls.

2.2 CONDENSER

A. Contractor shall furnish a flexible connector at each refrigerant piping connection to condenser. Furnish bronze tube, bronze braid with solder type connections as manufactured by Flexonics Inc.; or equal.

B. Unit shall be constructed of heavy gauge galvanized steel and painted with a weather resistant powder paint.

C. Refrigerant coils shall include condenser fan and compressor contactor with high and low pressure controls and factory installed line dryer.

D. Compressor shall have internal over temperature and pressure protection.

E. Outdoor unit to have external service valves and vibration isolators.

2.3 HORIZONTAL MOUNTED UNIT ACCESSORIES

A. Furnish unit with a high flow rate, pan type condensate removal pump, designed to fit next to cabinet. Unit shall be die-cast aluminum motor housing, check valve, epoxy finish, nylon volute and impeller, ABS plastic float, epoxy coated metal switch mechanism and all brass parts. Pump to provide 0.87 gph @ 26 feet hd. Furnish unit

with control float, filter screen, 120V/1Ph. Furnish Aspen mini lime pump Model #ASP-ML230, as manufactured by Little Giant Pump Co.; or an approved equal. Furnish with pvc cover.

PART 3 - EXECUTION

3.1 GENERAL

A. Locate condenser to allow sufficient space for air flow and servicing space requirements.

B. Install unit in strict accordance with manufacturer's instructions.

C. After installation is complete, and just prior to completion of project, Contractor shall clean condenser coils, by an approved method, to remove dirt and debris which may have accumulated during construction.

D. Provide (2) equipment supports, Greenheck Model GESR; or equal, below each condensing unit on roof. Equipment support shall be constructed of 18 gauge welded galvanized steel, with base closure, wood nailer and flashing cap. Provide roof protector pad below entire support area.

END OF SECTION

SECTION 23 82 23

UNIT VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Schedule of all components.
B. Schedule of all accessories.
C. Indicate unit capacities on all equipment.
D. Indicate all field connection locations.
E. Unit Vent Arrangement drawings.
F. Unit accessory arrangement drawings.
G. Provide dimensional plan view drawings for accessory cabinets installations.
H. Wiring diagrams.
I. Submit color charts (unit and louver color selection by Architect).
J. Parts list, Operating & Maintenance manuals.
K. Installation instructions.
L. Written report co-signed by clerk of works confirming final filter set installation.

1.3 QUALITY ASSURANCE

A. Unit ventilators shall be listed by Underwriters Laboratories Inc. (UL) for the United States and Canada.

B. Motors shall conform to the latest applicable requirements of NEMA, IEEE, ANSI and NEC Standards.

C. Unit ventilation rate to be certified and tested per Air Conditioning and Refrigeration Institute (ARI) Standard 840.

D. Unit to be certified and labeled compliant with the seismic design provisions of the 2016 New York State Building Code including independent testing agency requirements.

1.4 GENERAL REQUIREMENTS

A. Unit vent supplier shall have locally available competent mechanics to provide all types of service for all supplied materials and equipment.

B. Service mechanics shall be factory trained and shall be certified, by the manufacturer, to perform all types of service on supplied equipment.

C. As a part of the initial installation, service mechanics shall start up and adjust units for proper operation.

D. All equipment factory supplied with unit (including manufacturer's controls or other Temperature Control components) shall be properly adjusted, on site, by service mechanics.

E. Equipment supplier shall provide service on all supplied equipment for full guarantee period at no cost to the Owner. Installation service shall include all work necessary for repair of defective, improperly installed or improperly adjusted equipment.

F. Motor efficiency shall comply with EISA standards.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Furnish self contained unit ventilator for MECHANICAL service of size, capacity, construction and speed as specified. Units to be fully equipped for intended service as shown on drawings and as specified.

B. Unit ventilator supplier shall locally maintain factory trained technicians capable of servicing supplied units.

2.2 SOUND POWER REQUIREMENTS

A. Schedule:

Unit Max CFM	Unit Size	Unit Speed	Sound Power Data (db re: 10^{-12} watts)						
750	S07	High	57.4	51.8	52.5	52.6	51.2	46.9	35.2
		Medium	50.1	44.9	45.6	44.8	42.8	34.2	19.9
		Low	45.6	40.4	40.8	39.1	35.7	24.4	12.0
1000	S10	High	57.0	52.8	53.9	53.7	51.5	46.8	35.9
		Medium	52.9	48.6	50.2	49.6	46.5	40.1	27.9
		Low	49.4	45.4	47.0	45.5	42.0	33.6	20.7
1250	S13	High	62.4	55.2	55.7	55.3	54.4	49.7	38.5
		Medium	59.3	52.1	52.5	51.7	50.4	44.0	31.8
		Low	55.6	48.6	49.1	47.2	45.6	37.1	24.0
1500	S15	High	63.8	56.6	58.0	58.2	56.4	52.4	41.9
		Medium	58.4	51.3	52.7	52.4	49.5	43.5	30.5
		Low	54.8	47.6	49.4	47.5	44.2	36.2	21.5
	Center Frequency		125	250	500	1000	2000	4000	8000
	Octave Band		2	3	4	5	6	7	8

B. Sound tests were conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32.

C. Sound test data is based on standard cfm at standard air (fixed density of air at 70°F) in accordance with ARI procedures based upon ARI 350.

D. To calculate the Noise Criteria (NC) for a room, use the sound power level for each octave band for the particular unit speed and subtract the actual room effect. The resulting sound pressure number for each octave band can then be graphed on a NC chart to determine the room NC level.

E. If necessary, the unit manufacturer may use a larger unit running at medium or low fan speed to meet the required maximum noise levels. However, provisions must be made to accommodate the larger units at no cost to the Owner.

2.3 CABINET AND CHASSIS:

A. Unit frames shall be of unitized, welded construction, with structural elements aligned in an assembly jig prior to welding, to insure proper dimensions, rigidity, and squareness. Frames assembled with mechanical fasteners shall not be acceptable.

B. Internal sheet metal parts shall be constructed of galvanized steel to inhibit corrosion.

C. Exterior cabinet panels shall be fabricated from furniture grade steel of not less than 16 gauge steel with no sharp edges and no unsightly screw heads and shall receive an electro-statically applied powder paint, and be oven baked with environmentally friendly thermosetting urethane powder finish to provide a high quality appearance. Finish color shall be as selected by Architect from manufacturer's standard colors.

D. Exterior cabinet panels shall be fabricated from furniture grade steel of not less than 18 gauge steel with no sharp edges and shall receive an electrostatically applied powder paint, and be oven baked with environmentally friendly thermosetting urethane powder finish to provide a high quality appearance. Finish color shall be off- white.

E. Heating only units shall be suitable for the later addition of a cooling coil and related components, without chassis modification for a drain pan.

F. The interior areas of the unit ventilator shall be insulated for sound attenuation and to provide protection against condensation of moisture on or within the unit. The unit shall be provided with an ultra-quiet sound package consisting of acoustically matched low speed fans to fan housing, sound barrier insulation material (non-fiberglass) adhered to the bottom underside of the unit top panel, sides of the fan section and sound absorbing insulation (non-fiberglass) material applied to the unit front panel.

G. Units shall be constructed so that testing and troubleshooting can be accomplished in the end pockets of operating units, without affecting the normal air flow patterns through the unit.

H. Each unit shall be provided with a non-fused power interrupt switch that disconnects the main power to the unit for servicing or when the unit is to be shut down for an extended period of time. The fan motor and controls shall have the hot line(s) protected by factory installed cartridge type fuse(s).

I. The manufacturer shall have published cataloged sound data available for the engineer's review. Sound data shall have been conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32. Sound test data shall be based on standard cfm at standard air (fixed density of air at 70F) in accordance with ARI procedures based upon ARI 350. The engineer shall have the right to reject equipment not conforming to the specified manufacturer's sound data, as a minimum.

J. The manufacturer shall have published cataloged sound data available for the engineer's review. Sound data shall have been conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32. Sound test data shall be based on standard cfm at standard air (fixed density of air at 70F) in accordance with ARI procedures based upon ARI 350. The engineer shall have the right to reject equipment not conforming to the specified manufacturer's sound data, as a minimum.

2.4 FLOOR UNITS:

A. Floor mounted units shall have an integral pipe tunnel for convenient crossover of piping and a built-in metal wire raceway from right end compartment to left end compartment to contain any line voltage electrical wiring separate from the air stream. Line voltage wiring shall not be touchable in the air stream of the unit during normal maintenance procedures of oiling bearings or motors. Unit shall come standard with a factory installed and wired disconnect switch.

B. Unit top surface shall be supplied with a charcoal bronze textured finish, to resist scuffing, reduce glare and help hide fingerprints. Unit top shall have two access doors, one at each end (for access to motor and bearings for easy servicing). The front and ends shall be available in a selection of architecturally pleasing colors by the manufacturer, for selection by the Architect.

C. Unit discharge grille shall be constructed of continuous rounded edge steel bars to provide 10 degree vertical deflection. A 1/4" painted, galvanized mesh screen shall be provided beneath the discharge grille to protect against objects being dropped through the discharge grille.

D. The unit top and grille shall be of a modular construction so that it is removable for service and maintenance.

E. The unit front surface shall be comprised of three separate removable panels. The controls and piping shall be accessible without removing the entire front panel. Panels shall be secured to the unit with recessed, tamper resistant, Allen head fasteners. Slots for flat head screwdrivers shall not be acceptable as tamper resistant.

F. An extended cabinet depth unit, 21 7/8" deep, shall incorporate a full adapter back with closed pipe tunnel with the same features of the standard cabinet depth units with the additional capability of bringing in fresh air from 1" to 28" from the floor. The unit top, back and vertical adapter back partitions shall be insulated and sealed to form a thermal barrier. The vertical and horizontal insulated metal extensions shall have a 1" wide compressible gasket to form an airtight seal between the wall and the unit. A field removable horizontal support plate between the unit bottom and top to achieve the 1" to 28" fresh air access shall not be acceptable.

2.5 COILS:

A. Coil assembly shall be of a modular construction so that it is removable from the bottom of the unit.

B. Coil assembly shall be of a modular construction so that it is removeable from the front of the unit.

C. All coils shall be installed in a draw through position to assure uniform air distribution over the full-face area of the coil, and an even unit discharge temperature.

D. All heating and cooling coils shall be constructed with copper tubes and mechanically bonded aluminum corrugated plate type fins. All coils shall have aluminum individual unshared fin surfaces. An air break shall exist between coils.

E. Water heating and cooling coils shall be furnished with a threaded drain plug at the lowest point and a manual air vent at the high point of the coil. A factory installed low temperature freezestat shall be provided on the leaving edge of the water heating coil in a wave-like configuration to sense multiple locations and shall react to possible freezing conditions. The unit-mounted controls shall incorporate this device.

2.6 DRAIN PAN

A. All units (either heating only, heat/cool, cool only or reheat) shall come furnished with an insulated drain pan constructed of stainless steel. A drain outlet shall be provided on both ends of the drain pan with one outlet capped. The drain hand of connection shall be easily field-reversed by relocating the cap to the opposite end without disassembly of the unit or movement of the unit drain pan.

B. The drain pan shall be able to be sloped in either direction for proper condensate removal.

C. Drain shall be provided with a secondary, overflow drain connection on both ends of the pan.

2.7 FANS AND MOTOR:

A. The fan and motor assembly shall be of a low speed design to assure maximum quietness and efficiency.

B. Fans shall be double-inlet, forward-curved, centrifugal type with offset aerodynamic blades. Fans and shaft shall be statically and dynamically balanced as an assembly in the unit before shipment.

C. Fan housings shall be constructed of galvanized steel incorporating logarithmic expansion for quiet operation. Fan and motor assembly shall be of the direct drive type. Belt drive fans shall not be allowed.

D. Motors shall be 265 volt, single phase, 60Hz, ECM with auto reset internal thermal overload device designed specifically for unit ventilator operation. Motors shall be located out of the conditioned air stream.

E. High Static units with external static pressures (ESP) up to 0.45 shall utilize an Electrically Commutated Motor (ECM).

F. All components of the fan/motor assembly shall be removable from the bottom of ceiling mounted units.

G. All components of the fan/motor assembly shall be removable from the top of floor-mounted units.

H. Units shall have sleeve type motor and fan shaft bearings , and shall not reqiure oiling more than annually. All bearings shall be located out of the airstream. Bearings in the air stream are not acceptable.

I. Units shall have sleeve type motor and fan shaft bearings , and shall not require oiling more than annually.

J. ECM Motor speed shall be factory programed for three (3) speeds, HIGH-MEDIUM-LOW-OFF (not accessible from the exterior of the unit). Fan motor shall have hot leg protected by a factory installed cartridge fuse.

2.8 FACE & BYPASS DAMPER:

A. Each unit shall be provided with a factory-installed face and by-pass damper, constructed of aluminum. The long sealing edges of the damper shall have silicone rubber impregnated cloth seals for long life and positive sealing. Face and bypass dampers without sealing edges to prevent air bypass shall not be acceptable. The damper ends shall have blended mohair seals along the ends glued to the damper end for a positive seal. Plastic clip-on brush end seals shall not be acceptable as an end seal. The unit design shall incorporate the face and bypass damper to prevent coil surface wiping and be before the fan in a draw-thru configuration. The face and by-pass damper shall be arranged to have a dead air space to minimize heat pick-up in the by-pass position.

B. Each unit shall be provided with a factory-installed face and by-pass damper, constructed of aluminum. The long sealing surfaces of the damper shall seal positively against stops fitted with extruded EPDM rubber seals. Face and bypass dampers without sealing edges to prevent air bypass shall not be acceptable. The damper ends shall have blended mohair seals along the ends glued to the damper end for a positive seal. Plastic clip-on brush end seals shall not be acceptable as an end seal. The unit design shall incorporate the face and bypass damper to prevent coil surface wiping and be before the fan in a draw-thru configuration. The face and by-pass damper shall be arranged to have a dead air space to minimize heat pick-up in the by-pass position.

2.9 OUTDOOR & ROOM DAMPERS:

A. Each unit shall be provided with separate room air and outdoor air dampers.

B. The room air damper shall be two-piece, double-wall construction fabricated from aluminum, and be counterbalanced against backpressure to close by gusts of wind pressure, thereby preventing outdoor air from blowing directly into the room.

C. The outdoor air damper shall be two piece, double wall construction fabricated from galvanized steel, with ½" thick, 1½ lb. density glassfiber insulation encapsulated between the welded blade halves for rigidity and to inhibit corrosion. The outdoor air damper shall have additional foam insulation on the exterior surface damper blade and on the ends of the outdoor air chamber. A single blade damper, which can be twisted and will leak air, will not be considered.

D. Dampers shall be fitted with blended mohair seals along all sealing edges. Pressure adhesive sponge neoprene or plastic clip-on brush type sealers for damper seals are not acceptable. Rubber type gasket using pressure adhesive for fastening to metal and exposed to the outside air is not acceptable.

E. Dampers shall use the turned-metal principle on long closing ends with no metal-to-metal contact for proper sealing.

F. The damper shaft shall be mechanically fastened to the blade, and shall operate in bearings made of nylon or other material which does not require lubrication.

2.10 FILTER:

A. Each unit ventilator shall be equipped with a one-piece filter located to provide filtration of the return air/outdoor air mixture, in lieu of separate filters for each air stream. The entire filter surface must be useable for filtration of 100% room air or 100% of outdoor air. The filter shall be easily accessible from the bottom, and removable in one piece without removal of the unit return air damper stop. The unit shall ship with a factory installed 1" thick fiberglass, single-use type.

B. Prior to turning the space over to the owner, the contractor shall provide a new filter in the unit. The filter shall be a MERV 11 disposable filter.

2.11 CEILING UNITS (CEILING UNITS SHALL BE SIMILAR IN CONSTRUCTION TO FLOOR UNITS, WITH THE FOLLOWING ADDITIONAL FEATURES):

A. Three bottom panels, two of which are hinged, shall be provided for ease of service access and handling. Retainer chains shall be provided to prevent sudden release of the hinged bottom panels. End panels shall be secured to the unit with recessed, tamper resistant, Allen head fasteners. Slots for flat head screwdrivers shall not be acceptable as tamper resistant.

B. Ceiling mounted units shall have a built-in metal wire raceway from right end compartment to left end compartment to contain any line voltage electrical wiring separate from the air stream. Line voltage wiring shall not be touchable in the air stream of the unit during normal maintenance procedures of oiling bearings or motors.

C. The discharge opening of the unit shall be fitted with a duct collar.

D. The discharge opening of the unit shall be fitted with

E. A ceiling trim flange shall be provided for recessed units. The trim flange shall be 3-sided or 4-sided as required.

F. The centerline of the cooling condensate drain shall be a minimum of 4" above the bottom of the unit to allow for appropriate trapping of the condensate disposal line.

2.12 HORIZONTAL MOUNTED UNIT ACCESSORIES

A. **For all units with cooling**: Provide high flow rate, pan type **LOW PROFILE** condensate removal pump, designed to fit within cabinet. Unit shall be completely submersible, die-cast aluminum motor housing, check valve, epoxy finish, nylon volute and impeller, ABS plastic float, epoxy coated metal switch mechanism and all brass parts.

1. Pump to provide 80 GPH @ 1 FTHD. Furnish **LOW PROFILE** unit with control float, filter screen, 6 foot/3 conductor cord for 1/30 hp, 120V/1Ph. operation. Furnish Model #VCCA-20ULS, as manufactured by Little Giant Pump Co.; or an approved equal

2.13 TEMPERATURE CONTROLS

A. By temperature controls contractor. See Specification Section 230993 for details.

2.14 ACCESSORY CABINETS

A. General: Where shown on plans furnish all required accessory cabinets and closure panels for a complete proper installation. All accessory cabinets shall be manufactured by unit vent supplier and unless noted otherwise, shall exactly match unit vent dimensions and finish.

B. Provide accessory cabinets with all necessary trim pieces, filler section and end panels to result in a proper finished appearance. Accessory cabinets shall be reinforced steel construction to match unit vents. Furnish various sizes and types of cabinets to completely fill areas designated on plans. Cabinets shall be supplied to exactly fill wall to wall dimensions where required. Cabinets shall have adjustable mountings to allow exact alignment with unit vent; cabinets shall have adjustable kick plates.

C. Cabinets shall be equipped with rear compartment to accommodate piping and/or draft stop. Rear compartment shall be approximately 5-1/4" deep. All cabinets shall have finished back surfaces to fully conceal rear compartment.

D. Bookshelf Units: Shelf cabinets shall be self supporting with 4 adjustable legs. Units shall be capable of 3 book shelves with adjustable spacing heights. Units to be tagged as follows: 3' bookcase (BC-3), 2' bookcase (BC-2), 1' bookcase (BC-1).

E. The preferred widths for shelf cabinets shall be 3'-0". Shelf cabinets 5'-0" wide or greater are not acceptable; units 4'-0" wide will only be allowed by specific Engineers approval.

F. Book shelf units shall be capable of mounting optional doors with optional locks. Provide doors and accessories where indicated.

G. Utility Compartments: Utility sections shall be self supporting. Furnish width as shown or as required. Utility compartment shall include removable front panel with tamper resistant fastener, and shall be suitable for enclosing valves, controls, etc. Units to be tagged as follows: (UC-1) for a 12" utility compartment. (UC-1) for a 12" utility compartment, (UC-2) for a 18" utility compartment, (UC-3) for a 24" utility compartment.

H. Wall Pipe Enclosures: Refer to section 232113. Color selection by architect.

I. Filler Sections: Provide wall filler or corner filler section as required by space conditions. Filler section shall be nominal 18" wide field assembled unit. Unit to be tagged as follows: (FP-1).

J. Note: Heating piping is intended to be run in piping chase area in the back of the accessory cabinets. Contractor shall install accessory cabinets over piping as required.

K. Note: When draft stop is required wall enclosure shall have solid bottom and front without openings and a continuous extruded aluminum top bar grilles with adjustable damper(s).

L. Draft Stop: Where indicated on drawings: Furnish accessory cabinets under windows with "draft stop" down draft protection system. All cabinets and wall enclosures shall be equipped with continuous air inlet deluxe bar grilles located at back of cabinet tops. Provide adjustable damper below inlet grille.

M. Unit vents shall have factory installed 90% blank off panels on unit return air inlet. Units shall have factory installed draft stop return air passage ways installed internally.

N. Suppliers' installation service shall include balancing all draft stop return air dampers (using air velocity meter).

PART 3 - EXECUTION

3.1 GENERAL

A. Unit to be installed in strict compliance with manufacturer's instructions.

B. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

C. GC to provide openings for wall louvers, installation of louver by this contractor.

D. Contractor shall install galvanized sheetmetal wall sleeve for outside air intake opening. Secure OA wall sleeves to wall rough opening.

E. Contractor shall seal any openings water tight around wall sleeve. (Top, bottom and each end).

F. Pitch bottom of wall sleeve toward bottom of louver with non-shrink, non-metallic grout.

G. Care must be taken to insure weep holes in louver are not blocked.

H. Cabinets shall be leveled and exactly aligned with units and adjacent cabinets. Draft/stop dampers shall be adjusted for proper operation.

I. At the end of project in the presence of the owner's representative, Contractor shall remove and dispose of initial set of filters and replace with new additional set of filters on each unit. Furnish written report to Engineer confirming final filter set installation.

END OF SECTION

SECTION 23 82 30

TERMINAL RADIATION UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials, and installation instructions.

B. Schedule of equipment identified by room number with complete equipment description. Identify units with designations used on drawings.

C. Submit assembly type shop drawings showing unit dimensions, construction details, and field connection details.

D. Submit manufacturer's electrical requirements for power supply wiring to terminal units. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

E. At Engineer's request submit samples of each type of cabinet furnished.

F. Provide color chart for Architect's use.

PART 2 - PRODUCTS

2.1 FINNED TUBE RADIATION

A. General: Provide finned tube radiation of lengths and in locations as indicated, and of capacities, style and having accessories as scheduled.

B. Locate finned tube radiation on outside walls as indicated, and in accordance with manufacturer's installation instructions.

C. Center Elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window.

D. Install end trim where units butt against walls. Install end caps on units which do not butt walls. Install access panels centered in front of each shutoff valve, balancing cock, steam trap, or temperature control valve.

E. Cabinets: Minimum 20 gauge cold rolled steel full backplate, minimum 16 gauge front. Brace and reinforce front minimum of 4'-0" O.C. without visible fasteners.

F. Elements - For Hot Water: Copper tube and aluminum fins, with tube mechanically expanded into fin collars to eliminate noise and ensure durability and performance at scheduled ratings.

G. Elements - For Steam: Steel plate fins permanently bonded to steel tube with threaded ends. Fins to be embedded in the shell tube. Bond to be guaranteed under normal conditions for life of installation.

H. Finish: Flat black heat resisting paint for backplate; factory finished baked enamel, standard colors, selected by Architect on fronts and accessories.

I. Accessories: See drawings for arrangements. Provide accessories as shown on drawings, or specification, or as required for complete installation.
   1. End panels, inside and outside corners, and enclosure extensions.
   2. Access panels in front of all control, balancing and other valves, air vents and traps.
   3. Factory mounted dampers, sill extensions, mullion channels and pilaster covers.

2.2 PANEL RADIATORS:

A. General: Provide radiators having sizes in locations as indicated, and of capacities, style, and having accessories as scheduled.

B. Radiators shall be manufactured of cold rolled low carbon steel, fully welded and consisting of header pipes at each end, connected by flat oval water tubes.

C. Tube thickness shall be (high pressure) 0.078" minimum. wall thickness.

D. Header pipes shall be square 0.109' minimum wall thickness and include all necessary supply, return and air vent connections.

E. Piping connections are NPT taper threaded sockets, located in either side, or vertical positions. 3/4" Air vent connections are 1/8" NPT.

F. Rated working pressure shall be 128 psi maximum (tested at 184 psi).

G. Radiators shall be phosphatized and primed with flat white baked enamel and finish pained with a gloss baked enamel.

H. Color of the finish paint shall be selected by the Owner from available standard colors prior to ordering.

I. Pedestal mounting brackets shall be provided with radiators.

PART 3 - EXECUTION

3.1 INSTALLATION (HYDRONIC UNITS)

A. Isolate each unit with valves to permit servicing of control valves, traps, as shown on pertinent diagrams on plans.

B. Contractor responsible for correct end connections and coil arrangements, with respect to installation of control valves, traps, vents, etc.

C. Refer to Architects at once, any correction, discrepancy or suggested change in size or location.

D. Install all equipment in strict accordance with manufacturer's instructions.

E. Where covers require cutting joints shall be made to fit as closely as possible and shall be free from burrs and jagged edges. Unacceptable cuts shall be corrected at Contractor's expense.

F. Each unit shall have a minimum of (1) one union type connection on each end. Valves or traps with such type connections are acceptable as substitutes.

G. Eccentric reducers are required at all points on horizontal piping where pipe sizes change.

H. All steam radiation and associated horizontal piping must be pitched 1/4" in 10' (min) in direction of steam flow.

I. Provide manual air vent on return of each heating unit on all up-feed hot water installations.

END OF SECTION

SECTION 23 82 38

UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Manufacturer's data on equipment items listed.
B. Submit operating, installation and maintenance instructions.
C. Submittals shall be marked to identify specified information.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment tested for not less than 125 psig minimum hydrostatic pressure, unless otherwise specified. Free from expansion and contraction noises and strains. Fan speed on schedule is an indication of sound rating and shall not be exceeded. All exposed parts to be cleaned and bonderized or phosphate coated before prime coating or baked enameling. Baked enamel finish for unit heaters. Rating in accordance with standard test codes adopted jointly by IUGA and ASHRAE. Required capacities are shown in Schedule and Plans.

B. Provide unit heater suitable for use with hot water in accordance with schedule and/or as shown on plans.

C. Casings constructed of heavy gauge steel.

D. Provide with adjustable discharge louvers.

E. Motor efficiency shall comply with EISA standards.

2.2 HEATING COIL

A. Hydrostatically tested to 400 lbs. psi., maximum temperature 325°F.

B. Serpentine coil constructed of copper tubes and nonferrous fins.

C. Back or side connections to fit headroom requirements and appearance.

2.3 FAN AND MOTOR

A. Motor designed for continuous operation. Lubrication to be sealed in, permanent type. Provide approved vibration isolators.

B. Provide prewired room thermostat (where noted) at THL-1, mounted on intake of fan housing, wired to junction box. Thermostat to be heavy duty, concealed adjustment, contact rating at 10 Amps, 120 volts minimum, similar to Johnson Control Model T-26T-3.

C. Provide two wire 120 volt S.P.S.T.N.O. strap-on Aquastat set to open at 100°F (adjustable) model: L6006C 1018 Honeywell.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all secondary steel, hangers, vibration isolators, required for proper vibration and noise free operation.

B. Install all equipment in strict accordance with manufacturer's instructions.

C. Hang unit independent of piping.

END OF SECTION

SECTION 23 85 05

VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Drive options to be provide based on schedule.

B. All parts and equipment listed and specified in this section.

C. Submittals shall be marked to show specified information.

D. Submit a summary list of VFD's, bill of materials, dimension prints, wiring diagrams and product data sheets.

E. List of any exceptions to this specification

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 232123 - Circulating Pumps

B. Section 233416 - Centrifugal Fans

1.4 WORK REQUIRED

A. Provide all components as listed and as necessary for a complete operational system.

B. Mechanically install drives and accessories.

C. On systems with VF drives provide specialty motors with integral thermal overloads. Installation shall include all belts, sheaves, etc. for complete driveline. Contractor responsible for coordination of special requirements with fan equipment supplier. Properly align and adjust all motors, belts, etc. for proper operation.

D. Ensure installation is free of electrical noise on control and power circuits.

E. Provide training to Owner's designated representatives.

F. Contractor fully responsible for correction of all problems arising from improper installation of all motors.

G. DIVISION 26 SHALL:
   1. Electrically install drive, disconnects and accessories listed in this section.
   2. Furnish, install and connect power and safety wiring for all equipment listed.
   3. Provide control power to all panels and equipment requiring 120/1/60.
   4. Install safety and control wiring including Quick Break Signal to VF drive.

1.5 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. The VFD's must be manufactured and supplied by a company who has actively designing and manufacturing variable frequency drives in the USA for a period of at least ten years.

C. The VFD's carry UL or cUL independent testing company label. The VFD shall be rated and labeled according to Paragraph 53.4 of UL508C.

D. Additional standards include IEEE 519 - 2014, NEC 508, and NEMA.

E. All VFD's shall be from a single manufacturer and drives that are manufactured by a third party and "brand labeled" shall not be acceptable.

1.6 WARRANTY

A. The drive Product Warranty shall be 30 months from the date of shipment from the factory. The warranty shall include: Parts, on-site labor, and travel time and travel costs, or replacement of the complete drive as determined by the drive manufacturer's technical support.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD)

A. This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with both induction (asynchronous) motors, permanent magnet motors, synchronous reluctance motor (SynRM) and permanent magnet-assisted synchronous reluctance motor (PMa-SynRM/EC Titanium).

B. The drive manufacturer shall supply the drive and all necessary options as specified. All drives installed on this project shall be from the same manufacturer and have a common user interface (control panel). Drives that are manufactured by a third party and "brand labeled" shall not be acceptable.

C. This specification is intended to supplement a drive schedule. The drive schedule identifies the optimized BOM for the project and includes quantity, size, voltage, enclosure rating, options, and harmonic mitigation requirements of the drives. IEEE 519-2014 is an electrical system standard for harmonic mitigation and not intended to be applied to an individual piece of equipment. Drives are only one of many sources of

harmonics, thus verification of system IEEE 519-2014 compliance is beyond the VFD manufacturer's scope. The EOR (Engineer of Record) is responsible for conducting an electrical system study and verifying the drive schedule has specified proper harmonic mitigation for the drives.

2.2 DESCRIPTION

A. The drive package as specified herein and defined on the drive schedule shall be enclosed in a UL Type enclosure.

B. The drive shall provide full rated output from a line of +10% to -15% of nominal voltage across an ambient temperature range of -15 to 40° C (5 to 104° F).

C. All drives shall utilize the same Advanced Control Panel (keypad) user interface.
   1. Plain English text
      a. The display shall be in complete English words for programming and fault diagnostics.
      b. Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch or vibration trip. Customized terms, such as: AHU-1 End Switch or CT-2 Vibration shall also be available.
   2. The control panel shall include at minimum the followings controls:
      a. Four navigation keys (Up, Down, Left, Right) and two soft keys.
      b. Hand-Off-Auto selection, Fault Reset, and manual speed control.
      c. A Help key shall include assistance for programming and troubleshooting.
   3. There shall be a built-in time clock in the control panel with 10-year battery backup.
   4. I/O Summary display with a single screen shall indicate and provide:
      a. The status/values of all analog inputs, analog outputs, digital inputs, and relay outputs.
      b. The function of all analog inputs, analog outputs, digital inputs, and relay outputs.
      c. The ability to force all inputs and outputs to either a high, low, or specific value.
   5. The drive shall automatically backup parameters to the control panel. The drive shall allow two additional unique manual backup parameter sets to be stored.
   6. The control panel shall be removable, capable of remote mounting.

D. All drives shall have the following hardware features/characteristics as standard:
   1. Two (2) programmable analog inputs, two (2) programmable analog outputs, six (6) programmable digital inputs, and three (3) programmable Form-C relay outputs.
   2. The drive shall include an isolated USB port for interface between the drive and a laptop.
   3. An auxiliary power supply rated at 24 VDC, 250 mA shall be included.
   4. At a minimum, the drives shall have internal impedance equivalent to 5% to reduce the harmonics to the power line. 5% impedance may be from dual (positive and negative DC link) chokes, or AC line reactor. Drives with only one DC link choke shall add an AC line choke integral to the drive enclosure.

Reference the drive schedule to determine if additional harmonic mitigation is required for the system to comply with IEEE 519-2014.

5. The drive shall have variable speed primary cooling fans.
6. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 135% overload for 2 seconds every minute.
7. The input current rating of the drive shall not be greater than the output current rating.
8. Circuit boards shall be coated per IEC 60721-3-3; Chemical gasses Class 3C2 and Solid particles Class 3S2.
9. Coordinated AC transient surge protection system consisting of 4 MOVs (phase-to-phase and phase-to-ground), a capacitor clamp, and internal chokes. The MOVs shall comply with UL 1449 4th Edition.
10. The drive shall include a robust DC bus to provide short term power-loss ride through. An inertia-based ride through function should help maintain the DC bus voltage during power loss events. Drives with control power ride through only, are not acceptable.

E. All drives shall have the following software features as standard:

1. A Fault Logger that stores the last 16 faults in non-volatile memory. The most recent 5 faults save at least 9 data points, including but not limited to: Time/date, frequency, DC bus voltage, motor current, DI status, temperature, and status words.
2. An Event Logger that stores the last 16 warnings or events that occurred, in non-volatile memory. Events shall include, but not limited to: Warning messages, checksum mismatch, run permissive open, start interlock open, automatic reset of a fault, power applied, auto start command, auto stop command, modulating started, and modulating stopped.
3. Programmable start method. Start method shall be selectable based on the application and function even if the motor was freewheeling in the reverse direction: Flying-start, Normal-start, and Brake-on-start.
4. Programmable loss-of-load (broken belt / coupling) indication. This function to include a programmable time delay to eliminate false loss-of-load indications.
5. Motor heating function to prevent condensation build up in the motor. Motor heating adjustment, via parameter, shall be in "Watts."
6. There shall be a run permissive circuit for damper or valve control.
7. Four separate start interlock (safety) inputs shall be provided. The control panel will display the specific safety(s) that are open.
8. The drive shall include a switching frequency control circuit that reduces the switching frequency based on actual drive temperature. It shall be possible to set a minimum and a target switching frequency.
9. The ability to automatically restart after non-critical faults.
10. PID functionality shall be included in the drive.
11. Drive shall be compatible with an accessory that allows the control board to be powered from an external 24 VDC/VAC source.
12. A computer-based software tool shall be available to allow a laptop to program the drive. The drive shall be able to support programming without the need for line voltage. All necessary power shall be sourced via the laptop USB port.
13. The drive shall include a fireman's override mode.

F. Security Features
   1. The drive manufacture shall clearly define cybersecurity capabilities for their products.
   2. The drive shall include passcode protection against parameter changes. There shall be multiple levels of passcode protection including: End User, Service, Advanced, and Override.
   3. A checksum feature shall be used to notify the owner of unauthorized parameter changes made to the drive.
   4. The "Hand" and "Off" control panel buttons shall have the option to be individually disabled (via parameter) for drives mounted in public areas.

G. Network Communications
   1. The drive shall have an EIA-485 port with removable terminal blocks. The onboard protocols shall be BACnet MS/TP, Modbus, and Johnson Controls N2. Optional communication cards for BACnet/IP and LonWorks shall be available.
   2. The drive shall have the ability to communicate via two protocols at the same time, one onboard protocol and one option card based protocol.
   3. The drive shall not require a power cycle after communication parameters have been updated.
   4. The embedded BACnet connection shall be a MS/TP interface. The drive shall be BTL Listed to Revision 14 or later.

H. Disconnect – A circuit breaker or disconnect switch shall be provided when indicated on the drive schedule. The disconnect shall be door interlocked and padlockable. Drive input fusing shall be included on all packaged units that include a disconnecting means. All disconnect configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508A label.

I. Bypass – Bypass drive packages shall be provided when indicated on the drive schedule. All drive/bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508A label.
   1. The drive and bypass package shall be a complete factory wired and tested bypass system consisting of a padlockable disconnect device, drive output contactor, bypass contactor, and drive input fuses.
   2. The bypass control shall be powered by a three-phase switch mode power supply with a voltage tolerance of +30%, -35%. Single-phase power supplies and control power transformers (CPT) are not acceptable.
   3. The drive and bypass package shall be seismic certified and labeled to the IBC with a seismic importance factor of 1.5. Seismic certification shall include HCAI (formerly OSHPD) preapproval.
   4. All bypass packages shall utilize a LCD bypass control panel (keypad) user interface. The bypass control panel must be a separate display from the drive control panel.
   5. All bypasses shall have the following hardware features/characteristics as standard:
      a. Six (6) digital inputs and five (5) Form-C relay outputs.
      b. Drive isolation fuses shall be provided. Bypass designs which have no such fuses, or that only incorporate fuses common to both the drive and the bypass are not acceptable.

c. The bypass shall be able to detect a single-phase input power condition while running in bypass, disengage the motor, and provide a single-phase input power indication.
d. The bypass shall be designed for stand-alone operation and be completely functional in both Hand and Automatic modes, even if the drive and/or drive's control board has failed.

6. All bypasses shall have the following software features as standard:
   a. Programmable loss-of-load (broken belt / coupling) indication shall be functional in drive and bypass mode.
   b. Run permissive and start interlock control functionality shall be functional in bypass mode.
   c. The bypass control shall monitor the status of the drive and bypass contactors and indicate when there is a welded contactor contact or open contactor coil.
   d. The bypass shall include a selection for either manual or automatic transfer to bypass.
   e. The drive and bypass shall be designed to operate as an integrated system when in Override mode. There shall be four selectable Override modes: Bypass only, drive only, drive then transfer-to-bypass upon fault, and force to stop.
7. Network communications – the bypass shall include BACnet MS/TP, Modbus, and Johnson Controls N2 as standard. Optional communication cards for BACnet/IP and LonWorks shall be available.

2.3 QUALITY ASSURANCE AND FACTORY TESTS

A. Power Modules shall be tested to ensure correct function and highest reliability.

B. Every controller will be functionally tested with a motor to ensure that when the drive is started up according to the instruction manual provided, the unit will run properly. Load tests and burn in of the VFD must be performed in the United States factory where the VFD is manufactured.

PART 3 - EXECUTION

3.1 GENERAL

A. Startup and Training:
   1. Contractor shall include in bid price factory startup by a factory trained and authorized technician. VFD's shall not be powered up without authorization from the VFD manufacturer. This technician shall complete a startup report that records all VFD data, settings, and a check list of tests and observations. The VFD manufacturer shall retain this report.
   2. Provide one training session on site by a VFD factory trained and authorized technician. This session shall review all operation and maintenance requirements plus the fundamentals of VFD's and their application to AC motors.

B. Unless otherwise noted, equipment in this section shall be group mounted for each space.

C. Provide all required miscellaneous devices for all systems under this contract whether or not specifically indicated or specified.

D. Include all necessary relays, auxiliary contacts, terminal blocks, etc. Size all devices in accordance with load being handled.

E. Refer to applicable control, power diagrams and schematics in Division 23 and Division 26.

F. All wiring shall be neatly executed, color coded and identified. Utilize wiring gutters etc., as required to give a neat and orderly arrangement. Equipment shall be identified by engraved name plates.

G. Field Wiring Requirements:
   1. Contractor shall coordinate wiring requirements with EC.
   2. Caution: Control wiring; input power wiring; and out power wiring; must each be run in separate metal conduits.
   3. Therefore, each drive unit requires (3) individual conduits for wiring connections, wire trays are not acceptable.
   4. Unless noted otherwise control wiring by this contractor, input power and output power wiring by EC.
   5. Do not mix control and power wiring in the same conduit or wiring space. Contractor is responsible for correcting all signal noise or other electrical noise related problems.

END OF SECTION

ELECTRICAL

DIVISION 26

SECTION 26 00 10

ELECTRICAL WORK GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 ALLOWANCES, ALTERNATES AND UNIT PRICES

A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.3 INTENT

A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.4 DEFINITIONS

As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Make	Indicates minimum requirements for equipment.
ERL	Existing to be relocated. (see definition of relocate).
EXR	Existing to remain. Make connections to maintain circuit.
Exposed	Work not identified as concealed.
Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.

Install	Mount or set equipment, device or fixture and make electric connections.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Provide	Furnish and install complete.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Roughing	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.5 SCOPE OF WORK

A. In general, the scope of work includes, but is not necessarily limited to the following:
   1. Pad mounted transformers, concrete pads and conduits.
   2. Power distribution: panelboards, feeders and conduits.
   3. Grounding of all services, raceway systems, disconnects and devices, etc.
   4. Interior lighting, wiring, conduits and switching.
   5. Power circuits to mechanical equipment.
   6. Fire Alarm System.
   7. Removal work

1.6 BASIS OF DESIGN

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger electrical feeders, circuit breakers, equipment, additional control devices and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.7 QUALITY ASSURANCE

A. Manufactures of equipment shall be firms regularly engaged in the production of factory fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided

1.8 LICENSING

A. Where required the contractor shall hold a license, issued or recognized by the authority having Jurisdiction, to perform electrical work.

1.9 INSPECTIONS

A. Provide rough in and final inspection by an electrical inspector certified by the AIAEI (the American International Association of Electrical Inspectors).

1.10 SUBSTANTIAL COMPLETION REQUEST FOR PUNCH LIST

A. Contractor shall submit a letter in email form stating that the work is substantially complete and ready for Punch List review by Engineer.

B. Contractor shall note which areas are substantially complete by Building (if multiple buildings) and by Area according to the Key Plan.

C. Contractor shall list all items that are known to be incomplete at time of submission.

D. If the request is for a partial Punch List, Contractor shall also include a list of room numbers/room tags.

E. When letter is received by the Engineer, site review(s) will be coordinated with the Construction Manager, Clerk, Architect.

1.11 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

A. All removed electrical equipment shall be removed from the site and properly disposed of.

B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies.

C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

1.12 CONTINUITY OF UTILITY SERVICES

A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.13 CODES AND STANDARDS

A. National Electrical Code: All work covered under these Contract Documents shall conform to the latest issue of the National Electrical Code.

B. Standards: All equipment shall meet all the requirements of ANSI, NEMA, IES, and IEEE standards.

C. Listing: All equipment and devices for which Underwriters' Laboratory has a listing service, shall be UL listed and bear the UL listing label.

D. All materials and installation methods shall comply with:
   1. 2020 New York State Building Code, including all applicable amendments supplements to the following:
      a. 2018 International Building Code
      b. 2018 International Existing Building Code
      c. 2018 International Fire Code
      d. 2018 International Plumbing Code
      e. 2018 International Mechanical Code
      f. 2018 International Fuel Gas Code
   2. 2020 Supplement to the New York State Energy Conservation Construction Code, including all applicable amendments to the following:
      a. 2018 International Energy Conservation Code
      b. 2013 ASHRAE 90.1
   3. 2020 Uniform Code Supplement (May 12, 2020)
   4. National Fire Protection Association (NFPA).
   5. New York State Department of Labor Rules and Regulations.
   6. The Americans with Disabilities Act.
   7. Local Utilities.
   8. New York State Department of Health.
   9. Local Municipality/City Codes and Ordinances and the Authority Having Jurisdiction.
   10. Local Fire Department.
   11. Insurance Carrier.
   12. New York State Department of Education.
   13. National Electrical Contractors Association (NECA)
   14. Occupational Safety and Health Administration (OSHA).

1.14 SUBMITTALS & SUBMISSION REQUIREMENTS

A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.

1. Within (30) days after receiving signed contract or notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed. Submit (8) copies of data unless otherwise specified by the architect.
2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.
3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page (s) shall also indicate project name and building name.
4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usages, model numbers, construction materials, performance, data, etc.
5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)
6. The Contractor shall insure that dimensions of equipment to be used conform to the space allocated for the equipment on the drawings.
7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.
8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.

B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.

C. Substitutions:

1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.
2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.
3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable.
4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.

5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.15 FIELD INSPECTION

A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.16 PERMITS, CERTIFICATES AND FEES

A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below. Costs for permits, fees etc. shall be included in the base bid amount.
   1. All required applications and permits to begin work.
   2. Certificate of inspection including Third-Party Agency.
   3. All municipal connection charges.
   4. All local utility charges (power, telephone, cable, etc.).
   5. Fees and charges shall be obtained directly from the respective authority having jurisdiction.

1.17 GUARANTEE

A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.18 TESTING AND INSPECTION

A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.

B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

C. Required local or municipal inspection. Process and present Owner with certificate indicating approval of such governing bodies.

D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.

E. Contractor is responsible to check rotation on all three-phase equipment prior to turning on equipment for temporary or permanent use.

F. Panelboard, Circuit Breaker, Transformer and Fuse Tests:
1. Energize all possible lighting and equipment loads for a period of not less than eight hours.
2. Check all fuses and circuit breakers for faulty tripping and excessive heat.
3. Tabulate phase current on all feeders.
4. Tabulate voltages at each panelboard (phase to phase and phase to neutral).
5. Reconnect branch circuits that vary over 5% between high and low current.
6. Reconnect transformer taps as required to adjust for high or low voltages.
7. All tabulation sheets shall be presented to the Architect for approval, make any corrections determined by the Architect.

1.19 RECORD DOCUMENTS

A. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record as-built documents. As-built drawings will include actual equipment location layout, service connections, etc.

B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.20 PENETRATIONS THRU FIRE RATED CONSTRUCTION

A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.

B. All penetrations from abandoned or removal electrical work shall be sealed fire safe by this contract.

C. All electrical penetrations through walls, floors, etc. shall be conduit sleeved.

D. All conduit penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This Contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

E. Electric panels installed in one- or two-hour fire rated walls shall be wrapped in an approved endothermic mat rated to maintain the assembly. Design Make: 3M Fire Protection Products.

F. Provide fire rated covers for recessed light fixtures and other recessed devices. Desing make: Tenmat Fire Rated Cover or equal.

1.21 CONFINED SPACES

A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.

B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.22 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, fixtures, panelboards, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, and the panelboard or interconnection box from which the branch circuit is served.

B. Drawings show general design and arrangement. Verify exact location and elevations at the job location. Do not scale plans and diagrams.

C. Drawings do not show all offsets, fittings, interferences, and elevation changes. Adjust installation of conduit, equipment location, etc. to accommodate work with the obstacles and interferences. Where a major and important rearrangement is necessary, report same to Architect for review. Obtain written approval for all major changes.

D. Prior to roughing in any back boxes for power or communications devices, thoroughly examine the architectural elevations, enlarged plans and details. Also exam vendor drawings and manufacturer instructions for equipment furnished by others or as part of this contract. Install back boxes in locations and at heights as indicated on these documents. If the locations are not detailed, issue an RFI to the construction manager to obtain them. Boxes that are roughed in without detailed location and heights will re-located at no additional cost to the contract by the electrical contractor.

E. Cooperate with all Contracts and Owners and determine the exact route of all raceway and location of all equipment.

1.23 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:
   1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be CAD drawings of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.
   2. HVAC Contract will provide prints and Cad drawings and submit the base plan to all major trades' Contractors.
   3. Electrical, Plumbing and Fire Protection Contracts will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

B. The listing of a manufacturer as “acceptable” does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems conform to the Specifications.

2.2 ACCESS DOORS

A. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to existing ceiling support system. Furnish with manufacturer’s factory applied prime paint and top coat of white enamel.
   1. Frames: Fabricate from 16-gage steel. Frames shall be compatible with the existing ceiling suspension system.
   2. Flush Panel Doors: Fabricate from not less than 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees.

B. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed. Provide a minimum of (2) cam locks for any units over 324 sq. inches.

C. Acceptable Manufacturers: Karp Associates, Inc.; Meadow Craft, Inc.; Milcor, Div.; Inryco, Inc.

2.3 U.L. LISTING

A. Equipment shall bear the Underwriter's Laboratories (UL), or other approved agency listing label. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with the National Electric Code and listed by U.L.

2.4 FIRE STOPPING

A. Fire-stopping for Openings through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:
1. Dow Corning Fire-Stop System Foams and Sealants.
2. Nelson Electric Fire-Stop System Putty, CLK and WRP.
3. Thomas & Betts - S-100 FS500/600.
4. Carborundum Fyre Putty.
5. Hilti Firestop Systems.
6. 3M Interam Endothermic Mats

PART 3 - EXECUTION

3.1 ROUGHING

A. Obtain approved roughing diagrams and exact locations of equipment for items furnished under other Divisions of the specifications. Do not rough in without approved drawing.

B. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. DO NOT SCALE PLANS. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owners' representative for approval before proceeding.

C. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

D. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

E. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the electrical contractor at no expense to the Owner.

F. For equipment and connections provided in this contract, prepare roughing drawings as follows:
   1. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.
   2. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.
   3. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.
   4. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.2 CUTTING AND PATCHING

A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.

B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.

C. Should changes, omissions or errors in electrical work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at contractor's expense.

D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.

E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.

F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.

G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc. Patching shall include repairs, painting, etc.

H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

I. Provide ceiling tile replacement for all electrical items mounted to ceiling after removals.

3.3 OPENINGS, SLEEVES, AND CHASES

A. Certain chases, openings, and shafts will be provided as shown as part of General Construction Plans and Specifications.

B. Provide all other openings and sleeves for conduit etc. through floors, walls, partitions, ceilings, roofs, etc. for Division 26-E work.

C. Assume responsibility for correct and final location and size of such openings; furnish templates if required. Correct improperly located and sized or omitted chases and openings as required. Plug all abandoned sleeves left as part of this Contract.

3.4 SEALING AND FIRESTOPPING

A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:

1. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.

2. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.
3. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.
4. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.
5. Where boxes are installed flush in a fire rated wall provide an approved endothermic wrap around the entire enclosure. Seal conduit penetrations with approved fire putty.

3.5 SUPPORTS

A. Provide required supports for work of this Contract, including beams, angles, channel, hangers, rods, columns, plates, bases, braces, etc. to properly support all work.

B. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.

C. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports.

D. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, securely bond to floor by roughening slab and coating with cement grout. Bases 2" high; shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.

E. See Specification Section 260530 – Supporting Devices for additional requirements

3.6 CONCEALMENT

A. Unless otherwise specifically indicated, all work shall be concealed above ceiling space, in wall space, below slabs in crawl spaces, and elsewhere throughout the building.

B. In areas with no ceilings, install only after Architect reviews and comments on arrangement and appearance.

3.7 ROOF AND ROOF DECK CUTTING AND FLASHING

A. All penetrations through roofing and decking shall be accomplished by the roofing manufacturer‘s Certified Roofing Contractor in order to maintain roof system warranty.

3.8 EQUIPMENT INSTALLATION

A. All installations shall comply with the following requirements:

1. Provide code required disconnects for all electrical equipment that is furnished or connected by the electrical contractor.
2. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
3. The architect shall control the placement of all wall and ceiling mounted electrical equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.
4. Verify all dimensions with field measurements.
5. Arrange for all chases, slots and openings in other building components that are not indicated on drawings, to allow for electrical installations.
6. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
7. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.
8. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
9. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.
10. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
11. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
12. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the owners representative.
13. All finished equipment surfaces damaged during construction shall be brought to “as new” condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.
14. Workmanship shall be as called for in the “Standard of Installation” published by the National Electrical Contractors Association (NECA).
15. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

16. No electrical equipment shall be hidden or covered up prior to inspection by the owners' representative. All work that is determined to be unsatisfactory shall be corrected immediately.
17. All electrical work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
18. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.
19. Install access panel or door where units are concealed behind finished surfaces.

B. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest version of the National Electrical Code.

C. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts,

D. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

E. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.

F. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

G. Layout of equipment, accessories and electrical systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or electrical systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.

H. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

3.9 COMMUNICATION SYSTEM WIRING AND CABLE

A. Communication systems wiring and cable not required to be installed in conduit and located in an environmental air space shall have a plenum rated jacket.

3.10 REMOVAL OF BALLAST IN EXISTING LIGHT FIXTURE

A. Assume ballasts contain PCB materials unless labeled otherwise, or test samples to show materials are not PCB; submit test report. Remove all ballasts from existing light fixtures indicated on contract documents. Dispose of all ballasts which do not have non-PCB labels in PCB containers, and pay all costs to have containers taken to EPA-approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing fixture, remove material deposited in fixture, and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owner's Representative.

3.11 FIRE ALARM DETECTOR COVERS AND TEMPORARY HEAT DETECTORS

A. Electrical Contractor is responsible to provide dust covers on all detectors whether new or existing in any area of construction. This shall be done in any area of construction even if there is no electrical work being done in this area. Coordinate with all trades.

B. Where existing detectors are removed in renovation or in additions provide temporary heat detectors and connect them to the building alarm system.

3.12 ROOF PENETRATIONS

A. Electrical Contractor is to refer to Division 7 for warranty requirements on existing roofs prior to any roof penetrations made.

3.13 PAINTING

A. This Contract Includes the following :
   1. Painting for all cut and patch work performed as part of Division 26 contract.
   2. Painting required for touch-up of surfaces damaged due to the installation of electrical work.
   3. Painting as required to repair finish of equipment furnished.
   4. Painting of all surface mounted raceways in finished areas.

3.14 CLEANING

A. After all tests are made and installations completed satisfactorily:

B. Thoroughly clean entire installation, both exposed surfaces and interiors.

C. Remove all debris caused by work.

D. Remove tools, surplus, materials, when work is finally accepted.

3.15 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical/electrical facilities or services.

3.16 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owners designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide, operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e., variable frequency drive and air handling unit) both manufacturer’s shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Training Session: A training session shall be held for each system and/or item listed below:

Item	Description	Training Hours For Each Bldg
1.	Power Distribution System Modifications	2

D. The instruction shall include the following types of information:
1. System overview
2. Major component designation
3. System operation procedures
4. Maintenance scheduling and procedures
5. Provide a list of spare components each system would normally require

E. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.

3.17 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. For projects containing multiple buildings, (3) three manuals shall be submitted separately for each building. Include the following:
   1. Equipment wiring diagrams.
   2. Manufacturer's instructions.
   3. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions.
   4. Recommended maintenance procedures.
   5. Include name, address, and telephone number of supplier manufacturer.
   6. Representative and service agency for all major equipment items.
   7. Panel schedules in hard copy and word or excel format.
   8. Bind above items in a three ring binder with name of project on the cover.
   9. Provide CD or DVD with all data in word, pdf, or excel format.

B. Refer to specific specification electrical specification sections for additional requirements.

C. Deliver to Owner's Representative before request for acceptance.

3.18 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the owners asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

END OF SECTION

SECTION 26 00 15

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SECTION INCLUDES

A. Interior demolition, removal and abandonment of interior electrical systems including fire alarm.

B. Cleaning and repair of existing equipment to remain.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching work: As specified in individual sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to beginning work inspect and test all existing electrical systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.

C. Verify circuiting arrangements are as shown on Drawings.

D. Verify that abandoned wiring and equipment serve only abandoned facilities.

E. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.

F. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with the owner and Utility Company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction.

D. Existing Electrical Service: Maintain existing power distribution system at all times. Disable system only to make switchovers and connections. Obtain permission from Owner and Architect/Engineer at least (72) hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system at all times. Disable system only to make switchovers and connections. Notify Owner, Architect/Engineer, and local fire service at least (72) hours before partially or completely disabling system. Minimize outage duration.

3.3 DEMOLITION EXISTING ELECTRICAL WORK

A. Demolish existing electrical work under provisions of Division 01, Division 02 and this section.

B. Remove existing installations to accommodate requirements for new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Provide blank cover for abandoned outlets which are not removed.

F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, poles, and other accessories.

H. Remove all abandoned utility and overhead service poles after removal of services.

I. Repair adjacent construction and finishes damaged during demolition work.

J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

K. Where branch circuit home run is called to be reused label circuit in junction box and remove all branch and switch leg wiring.

L. Where removal of branch circuit wiring effects devices or fixtures upstream or downstream, make permanent connections to maintain circuits. Existing circuits to remain must remain active. All required connections to maintain existing circuits must be made after normal hours and coordinated with the owner.

3.4 RELOCATION OF EXISTING BRANCH CIRCUIT CONDUITS

A. Where existing ceilings are removed re-support all conduit 8 ft on center and all open cabling 4 foot on center.

B. Utilize open top cable hangers for supporting cables.

C. Where existing equipment, fixtures or devices are scheduled for reuse in new ceilings, remove and store in safe dry space. Make temporary connections to maintain through wiring where devices are removed.

D. Where existing ceilings are being removed and new ductwork, piping, or equipment are being installed the electrical contractor shall relocate existing 1/2" - 1" conduits and associated wiring that interferes with the installation.

E. For the purpose of this contract, the Electrical Contract shall be assumed to provide the following quantities in additional to items identified on the drawings.
   1. (10) 50'-0" runs of (2) #12 AWG, (1) #12 AWG EGC branch circuit wiring in ¾"C. This shall included all need bends, offsets, junction boxes, and splices at both ends for a complete installation.

F. This work shall be done at no additional cost to the base contract.

3.5 RESUPPORT OF DEVICES CONDUIT AND WIRING AFTER CEILING REMOVAL

A. Where existing ceilings are removed re-support all conduit 8 ft on center and all open cabling 4 foot on center.

B. Utilize open top cable hangers for supporting cables.

C. Where existing equipment, fixtures or devices are scheduled for reuse in new ceilings, remove and store in safe dry space. Make temporary connections to maintain through wiring where devices are removed.

3.6 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Use mild detergent to clean all exterior and interior surfaces; rinse with clean water, and wipe dry. Replace lamps and broken electrical parts.

END OF SECTION

SECTION 26 01 90

SUPPORTING DEVICES

PART 1 -GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SECTION INCLUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

1.3 REFERENCES

A. Refer to Division 1.

B. NECA Standard of Installation (National Electrical Contractors Association).

C. NFPA 70 - National Electrical Code.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ANCHORING DEVICES

A. Sleeve Anchors (FS FF-S-325 Group II, Type 3, Class 3): Molly/Emhart's Parasleeve Series, Phillips' Red Head AN, HN, FS Series, or Ramset's Dynabolt Series.

B. Wedge Anchors (FS FF-S-325 Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly/Emhart's Parabolt Series, Phillips' Red Head WS, or Ramset's Trubolt Series.

C. Self-Drilling Anchors (FS FF-S-325 Group III, Type 1): Phillips' Red Head Series S or Ramset's Ram Drill Series.

D. Non-Drilling Anchors (FS FF-S-325 Group VIII, Type 1): Hilti's Drop-In Anchor Series, Phillips' Red Head J Series, or Ramset's Dynaset Series.

E. Stud Anchors (FS FF-S-325 Group VIII, Type 2): Phillips' Red Head JS Series.

2.2 CAST-IN-PLACE CONCRETE INSERTS

A. Continuous Slotted Type Concrete Insert, Galvanized:
   1. Load Rating 1300 lbs./ft.: Kindorf's D-986.
   2. Load Rating 2400 lbs./ft.: Kindorf's D-980.
   3. Load Rating 3000 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-H.
   4. Load Rating 4500 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-HD.

B. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded.

C. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept bolts having special wedge shaped heads.

2.3 MISCELLANEOUS FASTENERS

A. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work, selected from the following: Furnish galvanized fasteners for exterior use, or for items anchored to exterior walls, except where stainless steel is indicated.
   1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
   2. Lag Bolts: FS FF-B-561, square head type.
   3. Machine Screws: FS FF-S-92, cadmium plated steel.
   4. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
   5. Wood Screws: FS FF-S-111 flat head carbon steel.
   6. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
   7. Lock Washers: FS FF-W-84, helical spring type carbon steel.
   8. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required to sustain load.

B. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work; Phillips head screws and bolts for exposed Work unless otherwise specified.

2.4 HANGER RODS

A. Mid low carbon steel, unless otherwise specified; fully threaded or threaded each end, with nuts as required to position and lock rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

2.5 "C" BEAM CLAMPS

A. With Conduit Hangers:
   1. For 1 Inch Conduit Maximum: B-Line Systems Inc.'s BG-8, BP-8 Series, Caddy/Erico Products Inc.'s BC-8P and BC-8PSM Series, or GB Electrical Inc.'s HIT 110-412 Series.
   2. For 3 Inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf's 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.

3. For 4 Inch Conduit Maximum: Kindorf's E-231 beam clamp and E-234 anchor clip and C-149 series lay-in hanger; Unistrut Corp.'s P2676 beam clamp and P-1659A Series anchor clip with J1205 Series lay in hanger.

B. For Hanger Rods:
1. For 1/4 Inch Hanger Rods: B-Line Systems Inc.'s BC, Caddy/Erico Products Inc.'s BC, GB Electrical Inc.'s HIT 110, Kindorf's 500, 510, or Unistrut Corp.'s P1648S, P2398S, P2675, P2676.
2. For 3/8 Inch Hanger Rods: Caddy/Erico Products Inc.'s BC, Kindorf's 231-3/8, 502, or Unistrut Corp.'s P1649AS, P2401S, P2675, P2676.
3. For 1/2 Inch Rods: Appleton Electric Co. BH-500 Series, Kindorf's 500 Series, 231-1/2, OZ/Gedney Co.'s IS-500 Series, or Unistrut Corp.'s P1650AS, P2403S, P2676.
4. For 5/8 Inch Rods: Unistrut Corp.'s P1651AS beam clamp and P1656A Series anchor clip.
5. For 3/4 Inch Rods: Unistrut Corp.'s P1653S beam clamp and P1656A Series anchor clip.

2.6 CHANNEL SUPPORT SYSTEM

A. Channel Material: 12 gage steel.

B. Finishes:
1. Phosphate and baked green enamel/epoxy.
2. Pre-galvanized.
3. Hot dipped galvanized.
4. Polyvinyl chloride (PVC), minimum 15 mils thick.

C. Fittings: Same material and finish as channel.

D. UL Listed Systems:
1. B-line Systems Inc.'s B-22 (1-5/8 x 1-5/8 inches), B-12 (1-5/8 x 2-7/16 inches), B-11 (1-5/8 x 3-1/4 inches).
2. Grinnell Corp.'s Allied Power-Strut PS 200 (1-5/8 x 1-5/8 inches), PS 150 (1-5/8 x 2-7/16 inches), PS 100 (1-5/8 x 3-1/4 inches).
3. Kindorf's B-900 (1-1/2 x 1-1/2 inches), B-901 (1-1/2 x 1-7/8 inches), B-902 (1-1/2 x 3 inches).
4. Unistrut Corp.'s P-3000 (1-3/8 x 1-5/8 inches), P-5500 (1-5/8 x 2-7/16 inches), P-5000 (1-5/8 x 3-1/4 inches).
5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

2.7 MISCELLANEOUS FITTINGS

A. Side Beam Brackets: B-Line Systems Inc.'s B102, B103, B371-2, Kindorf's B-915, or Versabar Corp.'s VF-2305, VF-2507.

B. Pipe Straps:
1. Two Hole Steel Conduit Straps: B-Line Systems Inc.'s B-2100 Series, Kindorf's C-144 Series, or Unistrut Corp.'s P-2558 Series

2. One Hole Malleable Iron Clamps: Kindorf's HS-400 Series, or OZ/ Gedney Co.'s 14-G Series, 15-G Series (EMT).

C. Deck Clamps: Caddy/Erico Products Inc.'s DH-4-T1 Series.

D. Fixture Stud and Strap: OZ/Gedney Co.'s SL-134, or Steel City's FE-431.

E. Supporting Fittings for Pendent Mounted Industrial Type Fluorescent Fixtures on Exposed Conduit System:
1. Ball Hanger: Appleton Electric Co.'s AL Series, or Crouse-Hinds Co.'s AL Series.
2. Flexible Fixture Hanger: Appleton Electric Co.'s UNJ-50, UNJ-75, or Crouse-Hinds Co.'s UNJ115.
3. Flexible (Hook Type) Fixture Hanger: Appleton Electric Co.'s FHHF, or Crouse-Hinds Co.'s UNH-1.
4. Eyelet: Unistrut Corp.'s M2250.
5. Eyelet with Stud: Kindorf's H262, or Unistrut Corp.'s M2350.
6. Conduit Hook: Appleton Electric Co.'s FHSN, or Crouse-Hinds Co.'s UNH-13.

F. Supporting Fasteners (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erico Products Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Where specific fasteners are not specified or indicated for securing items to in-place construction, provide appropriate type, size, and number of fasteners for a secure, rigid installation.

B. Install anchoring devices and other fasteners in accordance with manufacturer's printed instructions.

C. Make attachments to structural steel wherever possible.

3.2 FASTENER SCHEDULE

A. Material:
1. Use cadmium or zinc coated anchors and fasteners in dry locations.
2. Use hot dipped galvanized or stainless steel anchors and fasteners in damp and wet locations.
3. For corrosive atmospheres or other extreme environmental conditions, use fasteners made of materials suitable for the conditions.

B. Types and Use: Unless otherwise specified or indicated use:
1. Cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.

2. Anchoring devices to fasten items to solid masonry and concrete when the anchor is not subjected to pull out loads, or vibration in shear loads.
3. Toggle bolts to fasten items to hollow masonry and stud partitions.
4. TPR fasteners to fasten items to plywood backed gypsum board ceilings.
5. Metallic fasteners installed with electrically operated or powder driven tools for approved applications, except:
    a) Do not use powder driven drive pins or expansion nails.
    b) Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
    c) Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
    d) Do not use powder driven fasteners in precast concrete.

3.3 ATTACHMENT SCHEDULE

A. General: Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.
1. Make attachments to steel bar joists at panel points of joists.
2. Do not drill holes in main structural steel members.
3. Use "C" beam clamps for attachment to steel beams.

B. Where it is not possible to make attachments to structural steel or steel bar joists, use the following methods of attachment to suit type of construction unless otherwise specified or indicated on the drawings:
1. Attachment to Steel Roof Decking (No Concrete Fill):
    a) Decking With Hanger Tabs: Use deck clamps.
    b) Decking Without Hanger Tabs:
        (1) Before Roofing Has Been Applied: Use 3/8 inch threaded steel rod welded to a 4 x 4 x 1/4 inch steel plate and installed through 1/2 inch hole in roof deck.
        (2) After Roofing Has Been Applied: Use welding studs, or self-drilling/tapping fasteners. Exercise extreme care when installing fasteners to avoid damage to roofing.
2. Attachment to Concrete Filled Steel Decks (Total thickness, 2-1/2 inches or more):
    a) Before Fill Has Been Placed:
        (1) Use thru-bolts and fish plates.
        (2) Use welded studs. Do not support a load in excess of 250 pounds from a single welded stud.
    b) After Fill Has Been Placed: Use welded studs. Do not support a load in excess of 250 lbs from a single welded stud.
3. Attachment to Cast-In-Place Concrete:
    a) Fresh Concrete: Use cast-in-place concrete inserts.
    b) Existing Concrete: Use anchoring devices.
4. Attachment to Cored Precast Concrete Decks:
    a) New Construction: Use thru-bolts and fish plates before Construction Work Contractor has placed concrete fill over decks.

5. Attachment to Hollow Block or Tile Filled Concrete Deck:
   a) New Construction: Use cast-in-place concrete inserts by having Construction Work Contractor omitting blocks and pouring solid blocks with insert where required.
6. Attachment to Waffle Type Concrete Decks:
   a) New Construction:
      (1) Use cast-in-place concrete inserts in fresh concrete.
      (2) If concrete fill has been applied over deck, thru-bolts and fish plates may be used where additional concrete or roofing is to be placed over the deck.
7. Attachment to Precast Concrete Planks: Use anchoring devices, except do not make attachments to precast concrete planks less than 2-3/4 inches thick.
8. Attachment to Precast Concrete Tee Construction:
   a) New Construction:
      (1) Use tee hanger inserts between adjacent flanges.
      (2) Use thru-bolts and fish plates, except at roof deck without concrete fill.
   b) Existing Construction:
      (1) Use anchoring devices installed in webs of tees. Install anchoring devices as high as possible in the webs.
   c) Do not use powder driven fasteners.
   d) Exercise extreme care in drilling holes to avoid damage to reinforcement.
9. Attachment to Wood Construction: Use side beam brackets fastened to the sides of wood members to make attachments for hangers.
   a) Under 15 lbs Load: Attach side beam brackets to wood members with 2 No. 18 x 1-1/2 inch long wood screws, or 2 No. 16 x 1-1/2 inch long drive screws.
   b) Over 15 lbs Load: Attach side beam brackets to wood members with bolts and nuts or lag bolts. Do not use lag bolts in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts and nuts or lag bolts in the side of wood members at the mid-point or slightly above. Install plain washers under all nuts.

LOAD	LAG BOLT SIZE	BOLT DIA.
15 lbs. to 30 lbs.	3/8 x 1-3/4 inches	3/8 inch
31 lbs. to 50 lbs.	1/2 x 2 inches	1/2 inch
Over 50 lbs. to load limit of structure.	Use bolt & nut	5/8 inch

      (1) Bottom chord of wood trusses may be utilized as structural support, but method of attachment must be specifically approved.
      (2) Do not make attachments to the diagonal or vertical members of wood trusses.
      (3) Do not make attachments to the nailing strips on top of steel beams.

10. Attachment to Metal Stud Construction: Use supporting fasteners manufactured specifically for the attachment of raceways and boxes to metal stud construction.
    a) Support and attach outlet boxes so that they cannot torque/twist. Either:
        (1) Use bar hanger assembly, or:
        (2) In addition to attachment to the stud, also provide far side box support.

3.4 CONDUIT SUPPORT SCHEDULE

A. Provide number of supports as required by National Electrical Code. Exception: Maximum support spacing allowed is 4'-0" for conduit sizes 3 inches and larger supported from wood trusses.

B. Use pipe straps and specified method of attachment where conduit is installed proximate to surface of wood or masonry construction.
    1. Use hangers secured to surface with specified method of attachment where conduit is suspended from the surface.

C. Use "C" beam clamps and hangers where conduit is supported from steel beams.

D. Use deck clamps and hangers where conduit is supported from steel decking having hanger tabs.
    1. Where conduit is supported from steel decking which does not have hanger tabs, use clamps and hangers secured to decking, utilizing specified method of attachment.

E. Use channel support system supported from structural steel for multiple parallel conduit runs.

F. Where conduits are installed above ceiling, do not rest conduit directly on runner bars, T-Bars, etc.
    1. Conduit Sizes 2-1/2 Inches and Smaller: Support conduit from ceiling supports or from construction above ceiling.
    2. Conduit Sizes Over 2-1/2 Inches: Support conduit from beams, joists, or trusses above ceiling.

3.5 LIGHTING FIXTURE SUPPORT SCHEDULE

A. General: Do not support fixtures from ceilings or ceiling supports unless it is specified or indicated on the drawings to do so.
    1. Support fixtures with hanger rods attached to beams, joists, or trusses. Hanger rod diameter, largest standard size that will fit in mounting holes of fixture.
        a) Where approved, channel supports may span and rest upon the lower chord of trusses and be utilized for the support of lighting fixtures.
        b) Where approved, channel supports may span and be attached to the underside of beams, joists, or trusses and be utilized for the support of lighting fixtures.

2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
    a) Where specified that an adequately supported outlet box is to support a fixture or be utilized as one point of support, support the box so that it may be adjusted to bring the face of the outlet box even with surface of ceiling.

B. Number of Supports For Ceiling Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.
1. Commercial and Industrial Fixtures:
    a) Support individual fixtures less than 2 feet wide at 2 points.
    b) Support continuous row fixtures less than 2 feet wide at points equal to the number of fixtures plus one. Uniformly distribute the points of support over the row of fixtures.
    c) Support individual fixture 2 feet or wider at 4 corners.
    d) Support continuous row of fixtures 2 feet or wider at points equal to twice the number of fixtures plus 2. Uniformly distribute the points of support over the row of fixtures.
    e) An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

C. Number of Supports for Wall Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.
1. Commercial and Industrial Fixtures:
    a) Support individual fixtures 2 feet long or less at 2 points.
    b) Support individual fixtures over 2 feet long at 3 points.
    c) Support continuous row fluorescent fixtures at points equal to twice the number of fixtures. Uniformly distribute the points of support.
    d) An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
2. Vandal Resistant, Fixtures:
    a) Support individual fluorescent fixtures 2 feet long or less at 4 points (each corner).
    b) Support individual fluorescent fixtures over 2 feet long at 6 points (each corner and midway along each side of longest axis).
    c) Support continuous row fluorescent fixtures at points equal to 6 times the number of fixtures. Uniformly distribute the points of support.
    d) An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

3.6 CHANNEL SUPPORT SYSTEM SCHEDULE

A. Use channel support system where specified or indicated on the drawings.

B. Channel supports may be used, as approved, to accommodate mounting of equipment.

C. Material and Finish:
   1. Dry Locations: Use 12 gage steel channel support system having any one of the specified finishes.
   2. Damp Locations: Use 12 gage steel channel support system having any one of the specified finishes except green epoxy/enamel.
   3. Wet Locations: Use 12 gage steel channel support system having hot dipped galvanized, or PVC finish.

END OF SECTION

SECTION 26 01 95

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SECTION INCLUDES

A. Nameplates and labels.

B. Wire and cable markers.

C. Conduit markers.

1.3 REFERENCES

A. Refer to Division 1.

B. NFPA 70 - National Electrical Code.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background
   1. Locations:
      a) Outside of each electrical panel. Indicate panel name.
      b) Control equipment enclosure. Indicate equipment name and branch circuit.
      c) Disconnects Indicate equipment name and branch circuit.
      d) Distribution panel breakers. Indicate load served.
   2. Letter Size:1/8 inch letters.

B. Labels: Circuit designation shall be indicated with clear adhesive tape, 3/16 inch black letters on clear background. Use only for identification of individual wall switches and receptacles and control device stations. Tape label shall be adhered to the faceplate of each device.

C. Provide flash protection label per NEC 110.16 for equipment furnished under this Contract including switchboards, panelboards, industrial control panels and motor control centers. Seton #M0547; or equal.

D. Provide labeling for 120/240V, 3-Phase, 4-Wire (Delta High Leg) Panelboards per NEC 408.3(F)(1) that reads, "Caution: B Phase has 208V to ground".

2.2 WIRE MARKERS

A. Description: Tape type wire markers.

B. Locations: Each conductor at panelboard gutters and each load connection.

C. Legend: Branch circuit or feeder number indicated.

2.3 PANEL SCHEDULES

A. Provide complete type written directory for each panelboard listing room number, function, etc., for each circuit breaker.

B. Provide type written updated panelboard directories for existing panelboards affected by this work.

C. Panel directory must also include the up stream panel that services the panel. (i.e. "Fed from MDP Circuits 2,4,6")

D. Include a Microsoft word or excel file with all panel schedules as part of the close out submittals.

2.4 DEVICES

A. Provide a tape label on all receptacle and switch coverplates, power poles, etc. listing panel designation and circuit number. Tape shall be attached to outside of receptacle or switch coverplates.

B. In permanent marker write the panel and circuit number on the wall behind receptacle cover plate or inside receptacle back box.

2.5 JUNCTION AND PULL BOXES

A. Identify junction and pullboxes for particular service such as power, lighting, fire alarm, telephone, intercom, public address, nurse call, etc. using stencil lettering on cover.

2.6 CONDUIT

A. Provide adhesive marking labels for raceway and metal-clad cable. The labels shall indicate voltage and service, and be located above ceilings every 75 feet and on wall mounted conduit in mechanical and equipment rooms.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using adhesive.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

END OF SECTION

SECTION 26 05 19

WIRE AND CABLE (600 V AND BELOW)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 WORK INCLUDED

A. Conductors.

B. MC Cable.

C. Terminations.

1.3 SUBMITTALS

A. Schedule of all wiring and cable usage.

B. Product data sheets for all wire and cable types.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Feeder, branch circuit and control wiring:
   1. Annealed Copper, 98% conductivity.
   2. Minimum wire size:
      a) #12 AWG for branch circuits
      b) #14 AWG for control and signal circuits
   3. #8 AWG Wire and above shall be stranded.
   4. 600 volt insulation for all wiring above 50 volts.
   5. 300 volt insulation permitted for all wiring below 50 volts.
   6. Thermal plastic with PVC insulation with nylon jacket, suitable for wet or dry locations, THHN/THWN 90 degree Celsius.
   7. 90 degree C maximum operating temperature rating.
   8. UL 83 Listed

B. Lighting fixture wire
   1. FREP/CPE coated stranded copper,
   2. Flame retardant EPR Insulation and CPE jacket.
   3. UL 44 listed

C. Flexible cords and cables shall be Type "SO" or "SJO.

D. Color Coding:
1. All circuits shall be color coded according to the following schedule:

Voltage	A PHASE	B PHASE	C PHASE	NEUTRAL
208Y/120V, 3 Phase	Black	Red	Blue	White
480Y/277V, 3 Phase	Brown	Orange	Yellow	Gray

*ALL GROUNDING CONDUCTORS SHALL BE GREEN

2. #6 AWG and smaller shall have insulation continuously colored as called for above.
3. #4 AWG and larger may by identified using a minimum 3" tape band.
4. Color code all conductors at all pullboxes, enclosures, and terminations.
5. Switched legs shall be identified with the same color insulation as the phase leg.

E. Acceptable manufacturers:
1. Cablec
2. Southwire
3. Okonite
4. Rome Cable
5. Pirelli

2.2 TYPE MC METAL CLAD CABLE

A. Construction:
1. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible metal tape.
2. Suitable for wet or dry locations.
3. Suitable for cable tray installations.
4. Do not install direct buried, in concrete, or in the presence of corrosive vapors.
5. Provide with separate integral grounding conductor.
6. Support every 6 feet.
7. Manufactured and installed in accordance with NEC Article 330
8. Make: Acceptable manufacturers:
   a) AFC
   b) Southwire
   c) United Copper Industries

2.3 METAL CLAD COMBINATION LIGHTING POWER AND CONTROL CABLE.

A. Cable Shall have following construction
1. Armor: Galvanized Interlocking Steel Strip (blue armor) or Interlocking Aluminum Strip
2. Solid or Stranded Copper Conductors
3. Insulated Conductor Type THHN
4. Neutral Conductor: White or Gray
5. Control Cables: 16 AWG Solid TFN Twisted jacketed pair (Purple/Gray)
6. Insulation Permitting conductors of control circuits to be placed in a cable with conductors of electric light, power, or Class 1 circuits

B. Standards
   1. UL 66, 83, 1479, 1569, 1581, 2556,File Reference E80042
   2. NEC 250.118, 300.22(C), 392, 396, 330, 501, 502,503, 530, 504, 505, 518, 520, 530, 645, 725
   3. Federal Specification A-A-59544 (formerly J-C-30B)
   4. Meets all applicable OSHA and HUD Requirements
   5. Cable Tray Rated
   6. UL Classified 1, 2, and 3 hour through penetration (Fire Stop) product, R 14141
   7. Environmental Air-Handling Space Installation per NEC 300.22(C)
   8. Power and/or lighting as well as signal and/or control conductors per NEC Section 725.136(I)(1)

C. Design Make: AFC MC Tuff Luminary Cable

2.4 LOW VOLTAGE CONNECTORS AND TERMINATIONS

A. Straight Splices, #26 AWG To #10 AWG:
   1. Nylon Insulated compression butt-splices.
   2. 600 volt, 90 degree C rated.
   3. Make: Burndy "Insulink", T&B "Sta-Kon", or approved equal

B. Straight Splices, #8 AWG and Larger:
   1. Two way, long barrel, compression type, copper
   2. Provide heat shrink tubing over splice.
   3. 600 volt rated.
   4. Make: Burndy "Hylink", T&N 54800 Series, or approved equal.

C. Pigtail Splices, #26 AWG to #10 AWG:
   1. Twist type pressure connector.
   2. 600 volt rated, 105 degree C.
   3. Size as required for number and size of conductors used.
   4. Make: T&B Scotchlock, or approved equal

D. Three Way Splices, #8 AWG and Larger:
   1. Three way, long barrel, compression type, copper.
   2. Provide tape or heat shrink tubing over splice.
   3. 600 volt rated.
   4. Make: Burndy "Hylink", T&B 54700 Series, or approved equal.

E. Lug Terminations for Control and Signal Wiring:
   1. Nylon insulated fork with compression termination of #26 AWG to #10 AWG.
   2. Nylon insulated ring with compression termination for #8 AWG and larger.
   3. 300 volt rated.
   4. Make: Burndy "Insulug", T&B "Sta-Kon", or approved equal.

F. Lug Terminations for Power Wiring:
   1. Long barrel, compression type, copper body, on hole for #8 AWG to #2/0 AWG.
   2. Long barrel, compression type, copper body, two hole, for #3/0 AWG and larger.

3. 600 volt rated.
4. Make:
   a) One-hole lug: Burndy "Hylug", T&B 54900 Series, or approved equal.
   b) Two-hole lug: Burndy "Hylug", T&B 54800 Series, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Route wire and cable as required to meet Project Conditions.

B. Install cable in accordance with the NECA "Standard of Installation."

C. Use stranded conductors for control circuits.

D. Use conductor not smaller than 12 AWG for power and lighting circuits.

E. Use conductor not smaller than 16 AWG for control circuits.

F. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 100 feet.

G. Identify and color code wire and cable under provisions of this section. Identify each conductor with its circuit number or other designation indicated.

H. Install cables in raceway as called for after the entire raceway system has been completed.

I. Install splices and connections in accessible outlet, pull, and junction boxes.

J. Insulate all splices and connections with UL Labeled plastic tape, heat shrink tubing, or plastic molded caps.

K. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.

L. Provide a green equipment ground with all feeders and all branch circuits' size per the NEC.

M. Provide dedicated white insulated neutral conductor for each branch circuit. Shared neutrals are not allowed.

N. Install a maximum of three phase conductors, three neutral conductors, and one grounding conductor in each home run. (Obtain approval for additional conductor fill where field conditions require. Adhere to NEC de-rating requirements.)

O. Provide stranded wire to motors, transformers, equipment, and vibrating machinery.

P. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.

Q. Use pulling means including fish tape, cable, and rope and basket type grips which will not damage cables or raceways. Use approved mechanical pullers for feeders and branch circuits as required for #6 AWG cable and larger. Do not use mechanical means to pull conductors No. 8 or smaller.

R. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.

S. Reconnect branch circuit wiring at panelboards as required to obtain a balanced three phase load on the feeders.

T. Properly splice and neatly coil extraneous wires in outlet boxes.

U. Wiring in panelboards and equipment enclosures etc. shall be neatly trained and arranged so as not to preclude access to the space or equipment contained therein. Provide all additional cable supports and ties required to comply.

V. The system shall be properly grounded and continuously polarized throughout, following the color coding specified.

W. Wiring within panelboards, control cabinets, pull boxes, wiring troughs and annunciator and/or alarm panels shall be neatly bundled together with ties not requiring tools to install. Two, three and four wire circuits emerging from the bundle shall be trained and tied individually.

X. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

APPLICATION	CABLE TYPES	DESIGN MAKE
General purpose Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon	Ideal - Yellow 77
High Temperature Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Ideal - Yellow 190
Utility construction &	Rubber, Neoprene, Nylon,	Aqua-Gell II

Maintenance	PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	
Cold Weather Construction & Maintenance	Rubber, Neoprene, Nylon PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua-Gel CW

3.2 CIRCUITING

A. The following takes precedence over the drawings:
   1. General purpose receptacle and lighting branch circuits may be combined in single conduits in accordance with NEC requirements and restrictions.
   2. Conductors serving individual pieces of equipment or grouped equipment or isolated ground branch circuits shall not be combined.
   3. Provide dedicated Neutrals.

3.3 SPLICES

A. Dry locations: For conductors #10 AWG and smaller use standard spring type pressure connectors or compression type connectors with insulating jackets.

B. For conductors #8 AWG and larger use compression type connectors and insulate in accordance with manufacturer's recommendations.

C. Damp locations: Use same type splices as indicated for dry locations and wrap with moisture sealing tape.

D. Wire runs shall be continuous. All splicing shall be done only in accessible boxes.

3.4 LOW VOLTAGE CONTROL WIRING

A. Low voltage control wiring shall not be run in same conduit system as power feeds. All low voltage control wiring in equipment shall be neatly bundled, identified and installed remote from any and all mechanical moving parts. All low voltage control wiring in walls shall be installed in conduit, the same as required for power wiring. All low voltage wiring above inaccessible ceilings shall be installed in conduit. All low voltage wiring exposed in finished spaces shall be installed in wiremold surface raceway. All low voltage wiring exposed in unfinished spaces shall be installed in conduit. All low voltage control wiring above accessible ceilings shall be bundled, neatly run at right angles and/or parallel to building steel, tied to steel as high as possible with no more than 3" sags; wire may not be laid on ceiling framing or supported by ceiling framing. Low voltage wiring shall not be run between decking flutes or above structural members.

3.5 TYPE MC METAL CLAD CABLE

A. MC Cable shall be permitted for up to 6' fixture whips from junction boxes above drop ceiling areas to recessed light fixtures.

B. MC Cable shall be permissible for up to 10 ft drop from junction box to outlets in walls. MC Cable shall be permitted for horizontal cabling in drywall partitions.

C. Type MC Cable shall not be used for feeders or branch circuit home runs to panelboards.

D. Support cable at intervals not exceeding 4 feet.

E. Bending radius shall comply with Article 330.24 of the NEC.

F. Provide insulating bushing at all termination points between the metal sheath and outlet or junction box.

G. Type MC Cable shall not be installed exposed with the exception of fixture drops in mechanical or equipment rooms. Secure the cable to fixture hangers using nylon or plastic ties.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SECTION INCLUDES

A. Grounding and bonding conductor materials.

B. Equipment grounding and bonding requirements.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. B3: Soft or Annealed Copper Wire.
   2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.
   3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   2. 1100: Powering and grounding sensitive electronic equipment.

C. International Electrical Testing Association (NETA).

D. National Fire Protection Association (NFPA):
   1. 70: National Electrical Code (NEC).
   2. 780: Lightning Protection Code.

E. Occupational Safety and Health Administration (OSHA):
   1. 29CFR 1910.7 Definitions and requirements for Nationally Recognized Testing Laboratories (NRTL).

F. Underwriters Laboratories (UL):
   1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   2. 467: Grounding and Bonding Equipment.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7, or a full member company of NETA.
   1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in PART 3.

B. Comply with NFPA 70, National Electrical Code.

C. Comply with UL 467.

D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
   2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

1.5 SUBMITTALS

A. Product Data for grounding wiring, grounding rods, connectors and connection materials, ground busses or plates, identification materials and grounding fittings.

B. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Kearney/Cooper Power Systems.
   2. Lyncole XIT Grounding.
   3. Salisbury: W. H. Salisbury & Co.
   4. Thomas & Betts, Electrical.
   5. Chance/Hubbell.
   6. O-Z/Gedney Co.; a business of the EGS Electrical Group.

2.2 WIRE AND CABLE GROUNDING CONDUCTORS

A. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding. The requirements below apply for new cables installed as well as for upgrading of identification of existing cables as indicated on drawings.
   1. Material: Copper. Use only copper wire for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. Equipment Grounding Conductors: Insulated with green color insulation.

C. Bare Copper Conductors: Conform to the following:
   1. Solid Conductors: ASTM B3.
   2. Assembly of Stranded Conductors: ASTM B8.
   3. Tinned Conductors: ASTM B33.

D. Color coding of ground cables - Where new or existing cables are concealed and not color-coded, any exposed portion of the cable and each end of the cable for a minimum of 2 feet shall be color coded by green tape overlaid with bright tracer color tape to form the tracer. Where routed through raceways, wire ways, cable trays or under raised floors, the color-coding shall be such that by removing or opening any cover, color-coding shall be visible. Where conductors are routed through cable trays, color-coding for a minimum length of 4 inches shall be accomplished at intervals not exceeding three feet between marking.

2.3 MISCELLANEOUS CONDUCTORS

A. Grounding Plates:
   1. Bare or tinned, annealed-copper. Size as per specifications or larger as indicated on drawings.

B. Braided Bonding Jumpers: Where electrical continuity across shock mounts is necessary, bonding jumpers shall be installed across each shock mount. Jumpers of this application should have a maximum thickness of 0.025 inch, so that the damping efficiency of the mount is not impaired. In severe shock and vibration environments, solid straps may be corrugated, or flexible tinned copper wire braid may be used. Braids are to be terminated with tinned copper ferrules.

C. Raceway Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted.

2.4 CONNECTOR PRODUCTS

A. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

PART 3 – EXECUTION

3.1 GENERAL

A. A separate ground conductor (green wire) shall be installed in all raceways for feeders, power and receptacle branch circuits and where called for on drawings.

B. All distribution and branch circuit panels shall have a separate ground bar

C. All metallic conduits 1-1/4" or larger shall have grounding bushings.

D. Equipment ground conductor shall be copper with Type THHN insulation, green only, up to and including #4; larger sizes may be bare conductor, or black and identified with green tape.

E. Paint, grease or other contaminates shall be cleaned from all surfaces before bonding ground conductor. (Painted surfaces shall be sanded and cleaned.)

F. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated.
   1. Install green, equipment grounding conductor with all feeder and branch circuit conductors.

G. Enclosures: Ground all enclosures of electrical and electronic wiring and distribution equipment in accordance with requirements of the NEC.

H. Conduit or cable shields shall not be used as the equipment grounding conductor.

3.2 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel, where indicated on drawings. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable and will be redone at the contractor's expense. Utilize 'smokeless' type weld kits for all exothermic welds performed in interior of structure

C. Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

D. Raceway Grounding: Surface metal raceways, wireways, or cable trays or cable rack systems shall be installed in a manner that ensures electrical continuity. Short insulated green copper bonding jumpers shall be installed between adjacent raceway sections, on both sides of each joint, to ensure proper bonding. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Jumpers shall be provided with compression connectors at each end of cable. Surface metal raceways, wireways, cable trays or cable rack systems shall be field drilled to provide bolting point for securing bonding jumper. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. Bolts and hardware shall be as per details or as approved for grounding purposes. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.

E. Other Grounding Systems: Any additional grounding systems used for electronic equipment shall be connected to the facility main ground plate, structural steel or exterior earth electrode system as shown on drawings.

F. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy "Hyground Connector", Thomas and Betts Compression Connector or equivalent equipment when operated at the manufacturers recommended pressure to develop a minimum force of 12 tons is acceptable as approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in the lightning protection system.

3.3 RACEWAY SYSTEMS

A. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250-122.

B. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.

C. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250-122. Connect the bonding jumper

between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.

D. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250-122 for all conduit expansion joints.

E. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250-122.

F. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250-122.

G. Provide isolated ground conductors of systems as called for on the plans.

H. Provide bonding bushings and connections in all of the following:
   1. Service equipment enclosures.
   2. Openings with eccentric or concentric knockouts.
   3. Openings using reducing washers.
   4. Hazardous locations.
   5. Greater than 250V to ground systems.

3.4 SECONDARY ELECTRICAL SYSTEMS

A. Solidly ground all transformer neutral conductors and enclosures to building steel, or a cold water pipe 1" or larger in size as called for in Table 250-122 of the National Electrical Code.

B. Provide an equipment grounding conductor from the point of termination back to the ground bus of the serving panelboard, switchboard, or transformer. Do not splice equipment grounding conductors.

C. Provide an equipment grounding conductors from the point of termination back to the ground bus of the serving panelboard, switchboard, transformer, or switchgear.

D. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

3.5 TESTS

A. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:
   1. For grounding non-current carrying metal parts associated with secondary distribution system: 25 Ohms.

B. Providing grounding tests to verify the above values. Where these values are not met, add additional ground rods or connections in order to meet these values.

END OF SECTION

SECTION 26 05 33

CONDUIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 WORK INCLUDED

A. Galvanized rigid steel conduit.

B. Liquid tight flexible metal conduit.

C. Electrical metallic tubing.

D. Flexible metal conduit.

E. Fittings and conduit bodies.

1.3 SUBMITTALS

A. Submit for approval a list of each product and the manufacturer.

1.4 REFERENCES

A. ANSI-C80.2, 1983: Specification for Rigid Steel Conduit, Enameled.

B. ANSI C80.3: Electrical Metallic Tubing, Zinc Coated.

C. ANSI/NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

D. NECA "Standard of Installation."

E. NEMA TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

F. NEMA TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.

G. NEMA, RN1, 1986: PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

H. NEMA, TC 6, 1983: PVC and ABS Plastic Utilities Duct for Underground Installations.

I. NEMA, TC 8, 1983: Extra strength PVC Plastic Utilities Duct for Underground Installations.

J. NEMA, TC 9, 1983: Fittings for ABS and PVC Plastic Utilities Duct and Fittings for Underground Installation.

K. NEMA, TC 10, 1983: PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.

L. The following U.L. Standards:
1. UL 1, 1985: Flexible Metal Electrical Conduit.
2. UL 3, 1984: Flexible Nonmetallic Tubing for Electric Wiring.
3. UL 6, 1981: Rigid Metal Electrical Conduit.
4. UL 360, 1986: Liquidtight Flexible Steel Conduit, Electrical.
5. UL 514B, 1982: Fittings for Conduit and Outlet Boxes.
6. UL 651, 1981: Schedule 40 and 80 PVC Conduit.
7. UL 797, 1983: Electrical Metallic Tubing.
8. UL 870, 1985: Electrical Wireways, Auxiliary Gutters and Associated Fittings.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Minimum Size: 3/4" unless otherwise specified.

B. Outdoor Locations, Above Grade: Use rigid steel conduit.

C. Indoor:
1. Concealed: Use EMT (electrical metallic tubing).
2. Exposed: Use EMT unless otherwise called for.

2.2 RIGID GALVANIZED STEEL CONDUIT

A. Steel, hot dipped galvanized on the outside and inside, UL categorized as Rigid Ferrous Metal Conduit (identified on UL Listing Mark as Rigid Metal Conduit - Steel or Rigid Steel Conduit).

B. Acceptable manufacturers:
1. LTV Steel
2. Triangle
3. Allied Tube
4. Steel Duct
5. Wheatland

2.3 ELECTRICAL METALLIC TUBING

A. Steel, galvanized on the outside and enameled on the inside, UL categorized as Electrical Metallic Tubing (identified on UL Listing Mark as Electrical Metallic Tubing).

B. Acceptable manufacturers:
1. Triangle
2. Wheatland
3. Allied Tube

4. Steel Duct
5. LTV Steel

2.4 FLEXIBLE METAL CONDUIT

A. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges. UL categorized as Flexible Metal Conduit (identified on UL Listing Mark as Flexible Steel Conduit or Flexible Steel Conduit Type RW).

B. Acceptable manufacturers:
1. Anaconda
2. American Flexible Conduit Co.
3. O-Z/Gedney
4. Thomas and Betts

2.5 LIQUID TIGHT FLEXIBLE METAL CONDUIT

A. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocking zinc coated strip steel. Interior surfaces shall be free from burrs and sharp edges. Provide with a liquid-tight jacket of flexible polyvinyl chloride (PVC). UL categorized as liquid-tight flexible metal conduit (identified on UL Listing Mark as Liquid-Tight Flexible Metal Conduit, also specifically marked with temperature and environment application data).

B. Acceptable manufacturers:
1. Allied
2. American Flexible Conduit
3. Carlon
4. Thomas and Betts

2.6 FITTINGS AND ACCESSORIES

A. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.

B. Fittings for electrical metallic tubing shall be compression type or single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.

C. Fittings for flexible metal conduit shall be center stopped, insulated throat, U.L. E-11852 listed.

D. Fittings for liquidtight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.

E. Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.

F. Die-cast or pressure cast fittings are not permitted.

G. Provide conduit bodies' types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

H. Insulated Bushings:
1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated throat; Appleton Electric Co.'s BU50l Series, Cooper/Crouse-Hinds' 1031 Series, OZ/Gedney Co.'s IBC-50 Series, Raco Inc.'s 1132 Series, Steel City/T & B Corp.'s BI-901 Series, or Thomas & Betts Corp.'s 1222 Series.
2. Threaded malleable iron with 150 degrees C plastic throat; Appleton Electric Co.'s BU501 Series, Cooper/Crouse-Hinds' H1031 Series, or OZ/Gedney Co.'s IBC-50 Series.

I. Plastic Bushings for 1/2 and 3/4 Inch Conduit:
1. 105 degrees C minimum temperature rating; Appleton Electric Co.'s BBU50, BBU75, Blackburn (T & B Corp.'s) 50 BB, 75 BB, Cooper/Crouse-Hinds' 931,932, or OZ/Gedney Co.'s IB-50, IB-75, Raco Inc.'s 1402, 1403, Steel City/T & B Corp.'s BU-501, BU-502, or Thomas & Betts Corp.'s 222, 223.
2. 150 degrees C temperature rating; Appleton Electric Co.'s BBU50H, BBU75H, Cooper/Crouse-Hinds' H-931, H-932, or OZ/Gedney Co.'s A-50, A-75.

J. Insulated Grounding Bushings:
1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB-50 Series, Cooper/Crouse-Hinds' GLL Series, OZ/Gedney Co.'s IBC-50L Series, Raco Inc.'s 1212 Series, Steel City/T & B Corp.'s BG-801 (1/2 to 2") Series, or Thomas & Betts Corp.'s 3870.
2. Threaded malleable iron/zinc electroplate with 150 degrees C plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB Series, Cooper/Crouse-Hinds' HGLL Series, or OZ/Gedney Co.'s IBC-50L Series, or Thomas & Betts Corp.'s 3870.

K. Sealant for Raceways Exposed to Different Temperatures: Sealing compounds and accessories to suit installation; Appleton Electric Co.'s DUC, or Kwiko Sealing Compound with fiber filler, Cooper/Crouse-Hinds' Chico A Sealing Compound with Chico X fiber, Electrical Products Division 3M Scotch products, OZ Gedney Co.'s DUX or EYC sealing compound with EYF damming fiber, or Thomas & Betts Corp.'s Blackburn DX.

L. Vertical Conductor Supports: Kellems/Hubbell Inc.'s Conduit Riser Grips, or OZ/Gedney Co.'s Type M, Type R.

M. Pulling-In-Line for Installation in Spare and Empty Raceways: Polypropylene monofilament utility line; Greenlee Textron Inc.'s Poly Line 430, 431, or Ideal Industries Powr-Fish Pull-Line 31-340 Series.

N. Acceptable manufacturers:
1. O.Z. Gedney
2. Steel City
3. Thomas & Betts

4. Cooper Crouse-Hinds
5. Carlon
6. Raco

2.7 EXPANSION FITTINGS

A. Galvanized steel expansion joints for RGS or EMT conduit, PVC for PVC conduit. Minimum 4" movement in either direction.

B. Weatherproof for outdoor applications.

C. At expansion joints in concrete pours, provide Deflection/Expansion fittings capable of movement of 3/4" in all directions from the normal.

D. Design Make: O.Z./Gedney, Type "AX" (exposed), "DX" (Concrete Pour)

E. Acceptable manufacturers:
1. O.Z./Gedney
2. Crouse-Hinds
3. Appleton

2.8 EXPANDABLE CONDUIT PLUGS

A. Seal open underground telecommunications conduits entering the building with expandable conduit plugs with rope ties.

B. Refer to drawings for underground entrance locations.

C. Design Make: Osburn Associates or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Install conduit in accordance with NECA "Standard of Installation".

B. PVC conduit is not permitted in any interior location within a school.

C. All conduit penetrations through fire-rated construction must be sealed with UL listed fire stopping. Refer to architectural drawings for locations.

D. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.

E. Minimum 1/2" trade size for branch circuit and fire alarm wiring.

F. Minimum 3/4" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.

G. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25% additional conduits.

H. Provide a code compliant ground path between all outlets and the established electrical system ground.

I. Coordinate all raceway runs with other trades.

J. Do not install raceways adjacent to hot surfaces or in wet areas. Maintain 12" clearance between conduit and surfaces with temperatures exceeding 104° F (40° C).

K. Provide expansion fittings with external grounding straps at building expansion joints.

L. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.

M. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations.

N. All exposed conduit mounted to a painted surface shall be painted to match that surface.

O. No conduit shall be run in or through an Elevator Machine Room, hoistway or pit unless it contains circuitry specifically required for the elevator or elevator related equipment.

P. No conduit shall be run in or through a Stairwell unless it contains circuitry specifically required for the Stairwell related equipment.

Q. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

R. Provide at least one junction or pullbox for each 360 degrees of bends.

S. Provide green ground wire in all EMT, flexible conduit, and non-metallic conduit.

3.2 INSTALLATION

A. Install raceways parallel or perpendicular to building walls, floors and ceilings.

B. Cut raceways square, ream ends to remove burrs, and bush where necessary.

C. Route conduit in and under slab from point to point. Do not cross conduits in slab. Provide U.L. approved rain-tight and concrete tight couplings and connectors. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings. Install conduit below the reinforcing mesh. Locate conduits to provide a minimum of 1" of concrete around conduit. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.

D. Install with a minimum of bends and offsets. Bends shall not kink or destroying the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.

E. Support raceways from building construction. Do not support raceways from ductwork, piping, or equipment hangers. Arrange supports to prevent misalignment during wiring installation. Support conduit using coated steel or malleable iron straps, lay in adjustable hangers, clevis hangers, and split hangers. Do not attach conduit to ceiling support wires. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

F. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.

G. Secure conduit within three feet of each outlet box, junction box, cabinet or fitting.

H. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.

I. Provide expansion fittings where conduits cross building expansion joints.

J. Wherever a cluster of (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.

K. Provide 4 spare 3/4-in. raceways from each flush mounted panelboard or cabinet to an area above the nearest accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.

L. Join non-metallic conduit using cement as recommended by manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

M. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.

N. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.

O. Core drill, sleeve, and fire stop all penetrations through existing floors.

P. In exterior or wet locations, provide minimum 1/4" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.

Q. Provide conduit supports based on the following table:

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
1/2", 3/4"	Concealed	7	10
1", 1-1/4"	Concealed	8	10
1-1/2" & larger	Concealed	10	10
1/2", 3/4"	Exposed	5	7
1", 1-1/4"	Exposed	7	8
1-1/2" & larger	Exposed	10	10

R. Conceal conduits in all locations except for mechanical and equipment rooms. Obtain owner's permission to run exposed conduits in other areas if existing conditions warrant exposed conduit.

3.3 REUSE OF EXISTING RACEWAYS

A. Number of Raceways: Do not change number of raceways to less than the number indicated on the drawings except when appropriate for advantageous reuse of existing exposed and concealed raceways (the contract documents do not indicate location, number, size or condition of existing raceways). Existing raceways may be reused if the following conditions are met:

B. The existing raceway must be of adequate size for the new conductors to be installed therein (NFPA 70 Chapter 9, Tables 1, 4, & 5; Appendix C, Tables C1-C12a). More circuits may be enclosed by existing raceways than the circuiting shown on the drawings provided conductor sizes are increased to compensate for derating (adjustment factors) and other considerations required by NFPA 70 Article 310-15.

C. Remove existing conductors.

D. Demonstrate to the Director's Representative that the existing raceway is clear of obstructions and in good condition.

E. Check ground continuity. When ground continuity of existing raceway is inadequate install insulated grounding bushings, grounding wedges, bonding straps, grounding jumpers or equipment grounding conductors to establish effective path to ground.

F. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

G. Install vertical conductor supports to replace existing or missing vertical conductor supports.

H. Install extension rings on existing boxes when the number of new conductors installed therein exceeds NFPA 70 requirements.

I. Furnish the Owners' Representative with marked up drawings showing size and routing of existing raceways with number and size of new conductors installed therein. The drawings will be forwarded to the design engineer for verification of NFPA 70 compliance.

3.4 RACEWAYS FOR FUTURE USE (SPARE RACEWAYS AND EMPTY RACEWAYS)

A. Draw fish tape through raceways in the presence of the Owners Representative to show that the raceway is clear of obstructions. Leave a pulling-in line in each spare and empty raceway.

3.5 RACEWAY INSTALLATION - SPECIAL AREAS

A. Raceways Exposed to Different Temperatures: Where portions of an interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from a warmer to a colder section through the raceway installation.

B. Heated Areas to Unheated Areas: After conductors are installed, seal interior of the raceway at the nearest conduit body, outlet or junction box in the heated area adjoining the unheated area.

3.6 RACEWAY SCHEDULE

A. Rigid Ferrous Metal Conduit
   1. Exterior above grade
   2. Transition elbows from above to below grade.
   3. Where specifically called for on plans.

B. Electrical Metallic Tubing:
   1. May be installed concealed as branch circuit conduits above suspended ceilings where conduit does not support fixtures or other equipment.
   2. May be installed concealed as branch circuit conduits in hollow areas in dry locations, including:
      a. Hollow concrete masonry units, except where cores are to be filled.
      b. Drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.
   3. May be installed exposed as branch circuit conduits in dry non-hazardous locations at elevations over 10'-0" above finished floor where conduit does not support fixtures or other equipment.

C. Flexible Metal Conduit: Install equipment grounding conductor in the flexible metal conduit and bond at each box or equipment to which conduit is connected:
   1. Use for final conduit connection to recessed lighting fixtures in suspended ceilings. Use 4 to 6 feet of flexible metal conduit, minimum size 1/2 inch, between junction box and fixture. Locate junction box at least 1 foot from fixture and accessible if the fixture is removed.
   2. Use 1 to 3 feet of flexible metal conduit for final conduit connection to:
      a. Emergency lighting units.
      b. Dry type transformers.

c. Motors with open, drip-proof or splash-proof housings.
d. Equipment subject to vibration (dry locations).
e. Equipment requiring flexible connection for adjustment or alignment (dry locations).

3. Use for concealed branch circuit conduits above existing non-removable suspended ceilings where rigid type raceways cannot be installed due to inaccessibility of space above ceiling.
4. May be installed concealed as branch circuit conduits in drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.

D. Liquid-tight Flexible Metal Conduit: Install equipment grounding conductor in liquid-tight flexible metal conduit and bond at each box or equipment to which conduit is connected:
1. Use 1 to 3 feet of liquid-tight flexible metal conduit (UL listed and marked suitable for the installation's temperature and environmental conditions) for final conduit connection to:
a. Motors with weather-protected or totally enclosed housings.
b. Equipment subject to vibration (damp and wet locations).
c. Equipment requiring flexible connection for adjustment or alignment (damp and wet locations).

3.7 FITTINGS AND ACCESSORIES SCHEDULE

A. General:
1. Use fittings and accessories that have a temperature rating equal to, or higher than the temperature rating of the conductors to be installed within the raceway.
2. Use zinc electroplate or hot dipped galvanized steel/malleable iron or cast iron alloy fittings and accessories in conjunction with ferrous raceways in dry and damp locations unless otherwise specified or indicated on the drawings.
3. Use insulated grounding bushings or grounding wedges on ends of conduit for terminating and bonding equipment grounding conductors, when required, if cabinet or boxes are not equipped with grounding/bonding screws or lugs.
4. Use caps or plugs to seal ends of conduits until wiring is installed to exclude foreign material.
5. Use insulated grounding bushings on the ends of conduits that are not directly connected to the enclosure, such as stub-ups under equipment, etc., and bond between bushings and enclosure with equipment grounding conductor.
6. Use expansion fittings where raceways cross expansion joints (exposed, concealed, buried).
7. Use deflection fittings where raceways cross expansion joints that move in more than one plane.
8. Use 2 locknuts and an insulated bushing on end of each conduit entering sheet metal cabinet or box in dry or damp locations.
9. Plastic bushing may be used on 1/2 and 3/4 inch conduit in lieu of insulated bushing.
10. Terminate conduit ends within cabinet/box at the same level.

B. For Rigid Metal Conduit: Use threaded fittings and accessories. Use 3 piece conduit coupling where neither piece of conduit can be rotated.

C. For Electrical Metallic Tubing: Use set screw type or compression type connectors and couplings.

D. For Flexible Metal Conduit: Use flexible metal conduit connectors.

E. For Liquid-tight Flexible Metal Conduit: Use liquid-tight connectors.

END OF SECTION

SECTION 26 05 34

SURFACE RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SECTION INCLUDES

A. Surface metal raceways.

B. Wireways.

1.3 REFERENCES

A. NECA (National Electrical Contractors Association) Standard of Installation.

B. NEMA WD 6 - Wiring Device Configurations.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum (3) years' experience.

PART 2 - PRODUCTS

2.1 SURFACE METALLIC RACEWAY

A. Multiple Communications or Branch Circuits (Medium Capacity):
   1. 0.82" H x 1.9"W.
   2. Metallic two piece raceway with single compartment.
   3. Color shall be Ivory color durable finish scratch-resistant surface that can be painted.
   4. Provide the following fittings as required for installation:
      a) Entrance End Fitting: nominal maximum dimensions of 2.75"W x 2.75"H x 4"L and 1.5" or 1.25" conduit opening
      b) Back Entrance End Fitting: same as entrance end fitting with internal radius.
      c) T fittings.
      d) Bridge fitting with radius for spanning existing raceways in varying widths from 1/2" to 4.

e) Flat internal and external elbows UL verified for a 2" bend radius and exceeding the recommendations of EIA/TIA 569A.

5. Design Make: Mono-Systems SMS2400 series raceway, SMS2457 series bridge fittings, SMS2410 series entrance end fittings, SMS 2442 and 2430 T fittings.
6. Acceptable Manufacturers:
   a) Mon-Systems SMS2400 Series.
   b) Wiremold 2400 Series.

B. Multiple Communications or Branch Circuits (High Capacity):
1. 1.5" H x 2.74"W.
2. Metallic two piece raceway with single compartment.
3. Color shall be Ivory color durable finish scratch-resistant surface that can be painted.
4. Provide the following fittings:
   a) Entrance End Fitting: nominal maximum dimensions of 3.7"W x 3.75"W x 4"L and 2.5" or 2" conduit openings.
   b) Back Entrance End Fitting: same as entrance end fitting with internal radius.
   c) T fittings.
   d) Flat internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A using internal radius components.
5. Design Make: Mono-Systems SMS3000 series raceway, with SMS3009, SMS3010 and SMS3018 fittings.
6. Acceptable Manufacturers:
   a) Mono-Systems SMS3000 Series.
   b) Wiremold 3000 Series.

C. Combination Power and Data Cables:
1. 1.75" H x 4.75"W.
2. Metallic two piece raceway with single or split compartment as called for on plans.
3. Color shall be Ivory color durable finish scratch-resistant surface that can be painted.
4. Provide the following fittings:
   a) Entrance End Fitting: nominal maximum dimensions of 4.75"W x 3"H x 4"L and 2.5" or 2" conduit openings
   b) Back Entrance End Fitting: same as entrance end fitting with internal radius.
   c) T fittings.
   d) Flat internal and external elbows with fiber optic radius.
5. Design Make: Mono-Systems SMS4200 series raceway, with SMS4205 SMS4214FO, SMS4211FO and SMS4209FO fittings
6. Acceptable Manufacturers:
   a) Mono-Systems SMS4200 Series.
   b) Wiremold 4000 Series.

D. Single Branch Circuit or Data Cable
1. One-piece raceway
2. Color shall be Ivory

3. Utilized for wall mounted phones and miscellaneous branch circuit power only.
4. Provide internal and external 90 degree fittings with radius.
5. Design Make: Mono Systems SMS700
6. Acceptable Manufacturers:
   a) Mono-Systems SMS700 Series.
   b) Wiremold 700 Series.

E. Provide miscellaneous boxes, extension rings, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.

2.2 WIREWAY

A. Manufacturers:
1. Square D.
2. Substitutions: Refer to Division 1.

B. Description: General purpose, Oil-tight, dust-tight, and Rain-tight type wireway.

C. Knockouts: Manufacturer's standard.

D. Size: As indicated on Drawings.

E. Cover: Hinged cover.

F. Connector: Flanged.

G. Fittings: Lay-in type with removable top, bottom, and side; captive screws.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.

B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.

C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.

D. Submit factory drawings detailing the installation. Include a complete part list.

E. Raceway shall be factory painted. Touch up raceway and outlet boxes as required upon completion of installation.

F. Provide new covers and device brackets in areas where existing raceway is called for reuse. Paint raceway to match existing upon completion.

G. Provide all required conduit entrance end fittings and elbows required for a complete installation.

H. Raceway shown on plans is diagrammatical only. Route raceway around existing room features as required.

I. Where existing conduits, pipes and other obstacles interfere with the installation of new raceway at 90 degree angles, provide bridge fittings to traverse the obstacle without rerouting. If this is not possible reroute the surface raceway or the existing raceway as directed by owners' representative.

J. Install Products in accordance with manufacturer's instructions.

K. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level. This shall be done for WM400BAC as well, even though raceway comes with adhesive.

L. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

M. Wireway Supports: Provide steel channel as specified in section 260190.

N. Close ends of wireway and unused conduit openings.

O. Ground and bond under provisions of section 260526.

END OF SECTION

SECTION 26 05 40

BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 WORK INCLUDES

A. Wall and ceiling outlet boxes.

B. Pull and junction boxes.

1.3 REFERENCES

A. NECA - Standard of Installation.

B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. NFPA 70 - National Electrical Code.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.5 SUBMITTALS FOR REVIEW

A. Provide Product Data for the following:
   1. Wall and ceiling outlet boxes
   2. Pull and junction boxes

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel. Not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2" male fixture studs where required.

C. Acceptable manufacturers:
1. Steel City
2. Raco
3. Appleton
4. Crouse Hinds

2.2 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of raintight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify locations of boxes and outlets prior to rough in. Thoroughly examine the architectural elevations and millwork shop drawings.

B. If outlets are not specifically shown on elevations and there is millwork or equipment associated with the outlets issue an RFI prior to rough in.

3.2 INSTALLATION

A. Install boxes in accordance with NECA "Standard of Installation."

B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as required by the National Electrical Code.

C. Consider location of outlets shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls. Adjust box location up to 10 feet if required to accommodate intended purpose.

D. Orient boxes to accommodate wiring devices oriented as specified in Section 262726

E. Maintain headroom and present neat mechanical appearance.

F. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

G. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 1.

H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

I. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

J. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

K. Do not install flush mounting box back to back in walls; Unless box is fire rated a minimum of 2-hours.

L. Do not fasten boxes to ceiling support wires.

M. Support boxes independently of conduit.

N. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers. Use gang box where more than one device is mounted together. Do not use sectional box.

O. Use gang box with plaster ring for single device outlets.

P. Use cast outlet box in exterior locations exposed to the weather and wet locations.

Q. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.

R. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2" deep boxes with square corners and dimensions to accommodate conductors installed.

S. Surface ceiling mounted outlet boxes shall be minimum 4" square, 1-1/2" deep, galvanized sheet metal.

T. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.

U. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet, provide floor outlet with carpet flange.

V. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline as follows:

1.	Toggle switches	46"
2.	Receptacle outlets	18"
3.	Receptacle outlets, above hot water or steam baseboard heaters.	30”
4.	Do not install receptacle outlets above electric baseboard heaters.	
5.	Receptacle outlets, weatherproof, above-grade	24"
6.	Branch circuit panelboards, to top of backbox	72"
7.	Distribution panelboards, to top of backbox	72"
8.	Terminal cabinets, control cabinets	72"
9.	Disconnect switches, motor starters, enclosed circuit breakers	48"
10.	Where structural or other interference's prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.	

3.3 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation and location of outlet box for equipment with equipment supplier and other trades as applicable.

B. Cut boxes in millwork using methods approve by manufacturer and architect.

3.4 ADJUSTING

A. Adjust flush mounting outlets to make front flush with finished wall material.

B. Adjust vertical and horizontal alignment of boxes as required.

C. Install knockout closures in unused box openings.

3.5 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 11 85

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SUBMITTALS

A. Shop drawings required on all items specified under this section. Include the following:
   1. Manufacturer's catalog sheets.
   2. Shop drawings showing: physical size and dimensioned layouts, nameplate data, location of all accessible components, pertinent installation details.

1.3 EFFICIENCY LEVELS

Transformers must comply with the Department of Energy 2016 efficiency levels as called for in the following two tables:

Single-Phase Efficiency		Three-Phase Efficiency	
KVa	Low Voltage	kVa	Low Voltage
15	97.7	15	97.89
25	98.0	30	98.23
37.5	98.2	45	98.4
50	98.3	75	98.6
75	98.5	112.5	98.74
100	98.6	150	98.83
167	98.7	225	98.94
250	98.8	300	99.02
333	98.9	500	99.14

PART 2 - PRODUCTS

2.1 INDOOR DRY TYPE TRANSFORMERS

A. Construction:
   1. Transformer coils shall be of the continuous copper wound construction and shall be impregnated with nonhygroscopic, thermosetting varnish.

2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. Cores for transformers greater than 500 kVA shall be clamped utilizing insulated bolts through the core laminations to provide proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.
3. Two winding insulating type construction.
4. Labeled for EPA Energy Star Program (based on NEMA TP1 Guide for Determining Energy Efficiency for Distribution Transformers), except where a specific type of dry type transformer is used for "CP" panels.

B. Transformers shall be 115°C temperature rise above 40°C ambient. Transformers shall be capable of carrying a 15% continuous overload without exceeding a 150°C rise in a 40°C ambient.

C. Transformers to have a K ratings as called for on the drawings.

D. All insulating materials shall be suitable for 220°C UL component recognized insulation system.

E. Taps: Provide NEMA Standard taps.

F. Enclosures:
1. Provide lifting brackets on all sizes.
2. Ventilated openings shall be such as to avoid accidental access to live parts.
3. Degrease, clean, phosphatize and paint the entire enclosure with (1) coat of zinc chromate primer and (2) coats of gray enamel.

G. The core and coil assembly shall be grounded to the enclosure by means of a flexible copper grounding strap of adequate size.

H. Mounting: Provide transformers up to and including 112-1/2 KVA suitable for floor, wall or ceiling mounting.

I. Vibration Isolation: Core and coil assemblies 30 KVA and larger to be mounted on rubber vibration isolators designed specifically to reduce 120 Hz sound and multiple harmonics.

J. All transformers shall be of the quiet type, operating at sound levels substantially below ANSI standards.

PART 3 - EXECUTION

3.1 GENERAL

A. Install transformers where indicated on drawings.

B. Provide flexible conduit connection on primary and secondary conduits connected to transformer housing.

C. Transformer shall not be located tight to walls, provide manufacturer's recommended clearance to wall for venting. Provide 12" clearance to wall unless noted otherwise.

D. For floor mounted transformers over 45 kVA, provide a 4" housekeeping pad.

E. Bolt transformers to floor or pad utilizing vibration isolators.

F. Install transformers with sufficient Code required clearances.

G. Do not install transformers under or over panelboards per N.E.C.

END OF SECTION

SECTION 26 24 00

POWER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SECTION INCLUDES

A. Circuit Breakers.
B. Distribution Panelboards.
C. Branch Circuit Panelboards.
D. Disconnect Switches.
E. Enclosed Circuit Breakers.
F. Low Voltage Fuses.

1.3 REFERENCES

A. The equipment referenced herein are designed and manufactured according to the following appropriate specifications.
   1. ANSI/NFPA70 - National Electric Code (NEC).
   2. ANSI/IEEE C12.1 - Code for Electricity Metering.
   3. ANSI C39.1 - Electrical Analog Indicating Instruments.
   4. ANSI C57.13 - Instrument Transformers.
   5. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   6. NEMA KS 1 - Enclosed Switches.
   7. NEMA PB 2 - Deadfront Distribution Switchboards, File E8681.
   8. NEMA PB 2.1 - Proper Handling, Installation, Operation & Maintenance of Deadfront Switchboards Rated 600V or Less.
   9. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
   10. UL 50 - Cabinets and Boxes.
   11. UL 98 - Enclosed and Deadfront Switches.
   12. UL 489 - Molded Case Circuit Breakers.
   13. UL 891 - Dead Front Switchboards.
   14. UL 943 - Ground Fault Circuit Interrupters.
   15. UL 1053 - Ground Fault Sensing and Relaying Equipment.
   16. UL 977 - Fused Power Circuit Devices.
   17. CSA 22.2 No. 5 - M1986 Molded Case Circuit Breakers.
   18. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.
   19. Federal Specification W-C-870 - Fuseholders (for plug and enclosed cartridge fuses).
   20. Federal Specification W-S-865 - Enclosed Knife Switch.
   21. NECA Standard of Installation (published by the National Electrical Contractors Association).

22. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
23. NFPA 70 - National Electrical Code.

1.4 SUBMITTAL FOR REVIEW

A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.

1.5 SUBMITTALS FOR CLOSEOUT

A. Maintenance Data: Include spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum (10) years' experience.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products in conformance with manufacturer's recommended practices as outline in applicable Installation and Maintenance Manuals.

B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.

C. Inspect and report concealed damage to carrier within their required time period.

D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS

A. General:
1. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.
2. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.
3. Provide multi-pole breakers with common trip.

4. When the circuit breaker has tripped, the handle shall move to a position between the "on" and "off" positions. Provide a visual indication that the circuit breaker has tripped.
5. The ampere rating shall be clearly marked on the face of the circuit breaker.
6. Any series rated fuse/circuit breaker installations shall be UL listed as recognized component combinations. Provide a label at the Series rated device reading "Caution - Series Rated System. _____A available". Provide identical replacement of equipment".
7. Make provisions to add circuit breaker handle locks.
8. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.
9. Where the highest continuous current trip setting is or can be adjusted to1200A or higher Reduced Energy Let-through setting (RELT) is required.

B. Thermal Magnetic Molded Case Branch Circuit Breakers:
1. Permanent trip unit containing individual thermal and magnetic trip elements.
2. Thermal trip unit shall be long time, non-adjustable, thermal overload trip.
3. Magnetic trip unit shall be instantaneous, electro-magnetic trip. Magnetic trip unit shall be adjustable for all frame sizes 225 amperes and larger.
4. Interchangeable rating plugs shall be provided for all frame sizes 400 amperes and larger.
5. 60°C terminal temperature rating for circuit breakers rated 125 amperes or below.
6. 75°C terminal temperature rating for circuit breakers rated above 125 amperes.
7. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.
8. Circuit breakers shall be plug-on [bolt-on]. I-Line type distribution circuit breakers are acceptable.
9. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.
10. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero sequence sensing ground fault module.
11. Design Make: Square D QO, QOB (250 volt), EH, EHB (480 volt), I-Line style (600 volt).
12. Acceptable Manufacturers:
    a) Square D.
    b) General Electric.
    c) Cutler Hammer/Eaton
    d) Siemens.

C. Standard Function Electronic Trip Molded Case Circuit Breakers:
1. Microprocessor based true RMS sensing current sensing device with accuracy to the thirteenth harmonic.
2. Sensor frame and rating plug size shall be as indicated on the Panelboard Schedule.
3. UL listed to carry 80% of the ampere rating continuously.
4. Provide the following time/current response adjustments:
    a) Long Time Pickup
    b) Long Time Delay
    c) Short Time Pickup
    d) Short Time Delay (I2t IN only)

e) Instantaneous Pickup
f) [Ground Fault Pickup]
g) [Ground Fault Delay (I2t OUT only)]

5. Provide a means to cover the trip unit adjustments in accordance with NEC Article 240-6(b).
6. Provide trip indication for overload, short circuit, and ground fault trips.
7. Tripping system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing.
8. Design Make: Square D LX, MX, NX, PX.
9. Acceptable Manufacturers:
   a) Square D.
   b) General Electric.
   c) Westinghouse.
   d) Siemens.

2.2 DISTRIBUTION PANELBOARDS

A. 600 Volt rated, maximum 1200 amperes.

B. Copper bus bars with high dielectric polyester insulators.

C. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.

D. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.

E. 100% rated neutral of the same material as the main bus. Panelboards shall be marked for non-linear load applications.

F. Provide ground bus of the same material as the main bus.

G. Interior trim shall be dead front construction.

H. Enclosures shall be galvanized steel construction with removable end walls and knockouts. If design make equipment is not used, verify enclosure will fit in space allotted.

I. Fronts:
   1. Surface mounted.
   2. ANSI 49 gray electrodeposited enamel.
   3. Fronts shall be one piece with door, and hinged to the enclosure where possible.
   4. Provide cylindrical tumbler type lock with three point latch. All locks shall be keyed alike to match existing panelboards
   5. Provide a clear plastic directory card holder on the inside of the door.

J. Design Make: Square D "I-Line".

K. Acceptable Manufacturers:
1. Square D "I-Line".
2. General Electric "Spectra".
3. Cutler Hammer "Pow-R-Line".
4. Siemens "Sentron S4 or S5".

2.3 240 VOLT BRANCH CIRCUIT PANELBOARDS

A. 240 Volt rated, maximum 400 amperes.

B. 3 Phase, 4 wire or 1 phase, 3 Wire as called for on panel schedule.

C. Copper bus bars with high dielectric thermoplastic insulators.

D. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.

E. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.

F. 100 % rated neutral of the same material as the main bus.

G. Provide ground bus of the same material as the main bus.

H. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.

I. Enclosures shall be nominal 20" wide by 6" deep, galvanized steel construction with removable endwalls and knockouts.

J. Fronts:
1. Surface or flush mounted as called for on the Panelboard Schedule.
2. ANSI 49 gray electrodeposited enamel.
3. Fronts shall be one piece with door, and hinged to the enclosure.
4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike to match existing panelboards.
5. Provide a clear plastic directory card holder on the inside of the door.

K. Design Make: Square D "NQ".

L. Acceptable Manufacturers:
1. Square D "NQ".
2. General Electric "A" Series.
3. Eaton "PRL 1A".
4. Siemens "Sentron S1".

2.4 480 VOLT BRANCH CIRCUIT PANELBOARDS

A. 480 Volt rated, maximum 400 ampere main circuit breaker or 600 ampere main lugs.

B. Copper bus bars with high dielectric thermoplastic insulators.

C. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.

D. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.

E. Provide ground bus of the same material as the main bus.

F. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.

G. Enclosures shall be nominal 20" wide by 6" deep, galvanized steel construction with removable endwalls and knockouts.

H. Fronts:
   1. Surface or flush mounted as called for on the Panelboard Schedule.
   2. ANSI 49 gray electrodeposited enamel.
   3. Fronts shall be one piece with door, and hinged to the enclosure.
   4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike to match existing panelboards
   5. Provide a clear plastic directory card holder on the inside of the door.

I. Design Make: Square D "NF".

J. Acceptable Manufacturers:
   1. Square D "NF"
   2. General Electric "AE" Series.
   3. Eaton "PRL 2A".
   4. Siemens "Sentron S2".

2.5 DISCONNECT SWITCHES

A. Three pole, single throw, or as called for on the drawings.

B. Quick-make, quick-break switch operating mechanism.

C. Heavy-duty, current rating as called for on the drawings, voltage rating as required by the equipment served.

D. All current carrying parts shall be plated to resist corrosion.

E. Lugs shall be removable and rated for 75°C temperature rating.

F. Switch blades shall be visible when the switch is in the open position and the door is closed.

G. Switch shall be padlockable in the OFF and ON positions.

H. Provide fusible switches with rejection type fuse holders and fuses as indicated on the plans or as per fed equipment requirements.

I. Provisions for a field installable electrical interlock.

J. Provide external override mechanism to open the disconnect switch door without opening the disconnect switch.

K. Enclosure shall be steel with gray baked enamel paint.

L. Provide NEMA type enclosures as called for on the drawings.

M. NEMA type 1 enclosures shall be equipped with knockouts.

N. Design Make: Square D.

O. Acceptable Manufacturers:
   1. Square D.
   2. General Electric.
   3. Cutler Hammer.
   4. Siemens.

2.6 ENCLOSED CIRCUIT BREAKERS

A. Circuit breakers shall be as specified above.

B. Ratings as indicated on plans and as required by the installation.

C. Short Circuit Withstand ratings of the assembly shall be equal to that of the circuit breaker.

D. Provide NEMA rated enclosure as called for on the drawings, and as required by the environment.

E. Externally operable handle, with provisions for padlocking in the OFF and ON position.

F. Gray baked enamel finish except for stainless steel, NEMA 4X enclosures.

G. Knockouts at the top and bottom of NEMA 1 enclosures.

H. Design Make: Square D.

I. Acceptable Manufacturers:
   1. Square D.
   2. General Electric.

3. Cutler Hammer.
4. Siemens.

2.7 LOW VOLTAGE FUSES

A. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide (1) complete set(s) of fuses for all fusible disconnect switches, plus (3) spare fuses of each size. Deliver spare fuses to the Owner and obtain receipt.

B. Acceptable manufacturers: Fuses 600 amperes and below: Bussman Type FRN-R (300 volts), Type FRS-R (600 volts) or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment to coordinate with installation details of other equipment associated with the power distribution system.

B. Provide miscellaneous bolts, washers, nuts, clips, lock washers, small hardware, etc., of durium or equal rust resistant material, to make a complete installation.

C. Provide complete installation in strict accordance with the equipment manufacturer's instructions, drawings and recommendations and as called for.

D. In the event of conflict, discrepancy or difference between manufacturer's instructions and Contract Documents, the more stringent requirements shall apply.

E. Unload, move, handle, set in place, install, erect, assemble, connect, test, and operate, etc. all items of electrical equipment as required.

F. Provide rigging to unload, move, transport, set in place, erect, etc. the switchboards.

G. Provide grounding as called for.

H. Provide minimum working clearance as described in NEC Article 110-26 and 110-34 for all electric equipment.

I. Provide additional working or aisle clearance as called for.

J. Verify cable/lug sizes for terminations. Where a feeder is sized larger than the lug, provide in-line splice to reduce conductor size to match equipment or breaker terminations.

3.2 INSTALLATION OF PANELBOARDS

A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6 feet to top of panelboard if possible. If required, install panelboard with the so that the center operating grip of the top breaker is not more than 6'-7" above the finish floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates under the provisions of section 260195.

G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: (5) 3/4". Identify each as SPARE.

H. Ground and bond panelboard enclosure according to section 260526.

I. Securely support all panelboard enclosures to walls. Install true and level.

J. Provide four empty 3/4" conduits and one empty 1-1/2" conduit from each flush mounted panelboard backbox to the accessible ceiling space.

K. Provide channel support between the wall and backbox for panelboards installed on outside walls.

L. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.

M. Measure steady state load currents on each panelboard feeder. Rearrange branch circuits in the panelboard to balance the load within 20% of each other. Maintain proper phasing.

N. For buildings with more than one nominal voltage system, provide permanently post label at each panelboard indicating the color coding of all phase, neutral, and grounding conductors

O. Where boxes are installed flush in a fire rated wall provide an approved endothermic wrap around the entire enclosure. Design Make: 3M Fire Protection Products. Seal conduit penetrations with approved fire putty.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, and Section 7.5 for circuit breakers.

3.4 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 SECTION INCLUDES

A. Receptacles.

B. Cover plates.

1.3 REFERENCES

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device - Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum (3) years' experience.

1.5 COORDINATION

A. The contractor and lighting fixture manufacturer are responsible for coordinating and guaranteeing that the driver/ballast dimmer combination will dim the driver or ballast to 1% or 10% as applicable. Utilize design make or acceptable manufacturers where possible. Provide equivalent devices from alternate manufacturers where required.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 GENERAL

A. Color of devices shall be as selected by the Architect.

B. Where devices are added to existing facilities the color shall match other existing devices in the room or vicinity.

C. All devices must be specification grade at a minimum.

D. Where devices are ganged together provide multi-device cover plates configured as required.

E. Design Makes are from Pass & Seymour. Equivalent products from the following manufacturers are acceptable.
1. Hubbell.
2. Leviton.
3. Lutron.

2.2 TAMPER RESISTANT GFCI RECEPTACLES

A. Dual mechanical shutter system to help prevent insertions of foreign objects.

B. 20 ampere rated.

C. No exposed terminals to a finger safe application before, during, and after installation.

D. Built-in connector features large brass terminal blades to ensure consistent, reliable electrical connections to Plug Connector.

E. Protection: if critical components are damaged and ground fault protection is lost, power to receptacle is disconnected.

F. Prevents line-load reversal miswire: no power to the face or downstream receptacles if wired incorrectly.

G. FSUL Listed (Federal Specification WC596).

H. Exceeds UL943 voltage surge requirements; survives 100x the required UL 3kA/6kV voltage surge test cycles.

I. Trip indicator light (red LED).

J. Mounting screws are shipped captive in the device and wall plate for easier installation.

K. High-impact-resistant thermoplastic construction.

L. Zinc-plated steel mounting strap.

M. Button colors matching the device face.

N. Dual-direction test and reset buttons.

O. Class A rated GFCI.

P. Provide Weather Resistant (WR) listed for receptacles installed in damp and wet locations.

Q. Design Make: Pass & Seymour 2097TRAW Series;

2.3 COVER PLATES

A. Weatherproof Cover Plates:
1. Weatherproof plastic in-use cover
2. Horizontal/vertical cover in clear MM410C that safely covers any electrical outlet
3. Universal Fit to enable same product for all types of receptacles.
4. Attached gasket and mounting hardware
5. Meet or exceeds OSHA and NEC (article 406.8[b][1] wet location requirements with the cord plugged into the receptacle.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation verify that outlet boxes are cut in at proper height; that wall openings are neatly cut and will be completely covered by wall plates.

B. If wall openings were made by general trades notify that contractor and owners representative and direct the cutting and patching requirements. If the openings were made by electrical contractor cut and patch opening using a qualified trades person.

3.2 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Do not share neutral conductor on load side of dimmers.

D. Install receptacles with grounding pole on top.

E. Connect wiring device grounding terminal to outlet box with bonding jumper and to branch circuit equipment grounding conductor.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas and above accessible ceilings.

I. Install protective rings on active flush cover service fittings.

J. When receptacle is mounted horizontally, neutral pole shall be on top.

K. Provide extension rings to bring outlet boxes flush with finished surface.

L. Provide receptacles at locations indicated and where required by special equipment with plug connection. Mount at height 18" AFF; unless noted otherwise on drawings.

M. Receptacles shall not be installed back to back unless otherwise noted.

3.3 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Verify that each receptacle device is energized.

C. Test all receptacles for proper voltage, grounding and polarity.

D. Test all GFCI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.

E. Test all receptacles for polarity, ground continuity and ground blade retention force per NFPA 99 Chapter 3-3 Section 3-3.3.3.

F. Rewire receptacles as required until receptacles test properly.

G. Clean exposed surfaces to remove splatters and restore finish.

3.4 DEVICE PLATES

A. Provide at locations indicated with size openings required for devices indicated.

3.5 WALL PLATES

A. Provide at locations indicated with size openings required for devices indicated.

B. Multi-gang switches, receptacles, etc. shall be in a common one piece plate.

END OF SECTION

ELECTRONIC SAFETY AND SECURITY

DIVISION 28

SECTION 28 31 11

FIRE ALARM SYSTEM - RENOVATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all modified General Conditions, and Division 1 specification Sections apply to the work of this Section.

1.2 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.3 GENERAL REQUIREMENTS

A. This project includes the renovations and alterations the existing Simplex 4100ES Addressable fire alarm system.

B. Provide all equipment and accessories for a complete, electrically supervised, fire alarm system.

C. All new devices shall be listed for use with the existing system.

D. Maintain existing Fire Alarm Control Panel and devices as required to accommodate renovations. Disassemble, disconnect and transport equipment to new locations, then clean, test, and install ready for use. Provide additional wiring as required to relocate devices.

E. Obtain vendor shop drawings for exact quantities of existing devices undisturbed by renovations. Provide additional wiring as required to extend and reconnect existing devices to relocated locations. Work that is not properly coordinated with vendor will be corrected at no additional cost to the owner.

1.4 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and NFPA 101.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

D. Installer Qualifications: Company specializing in installing the products specified in this section with minimum three years experience.

E. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.5 REFERENCES

A. Codes
   1. The following Articles of the National Electric Code (NFPA 70)
      a) Article 760 - Fire Alarm Systems
   2. The following National Fire Protection Agency (NFPA) standards:
      a) NFPA 72 - National Fire Alarm Code
      b) NFPA 90A - Installation of Air Conditioning and Ventilating Systems
      c) NFPA 101 - Life Safety Code
   3. The following U.L. Standards:
      a) UL 864/UOJZ,APOU - Control Units for Fire Protective Signaling Systems
      b) UL 268 - Smoke Detectors for Fire Protective Signaling Systems
      c) UL 268A - Smoke Detectors for Duct Applications
      d) UL 521 - Heat Detectors for Fire Protective Signaling Systems
      e) UL 228 - Door Holders for Fire Protective Signaling Systems
      f) UL 464 - Audible Signaling Appliances
      g) UL 1638 - Visual Signaling Appliances
      h) UL 38 - Manually Activated Signaling Boxes
      i) UL 346 - Waterflow Indicators for Fire Protective Signaling Systems
      j) UL 1481 - Power Supplies for Fire Protective Signaling Systems

B. Building Code of New York State

C. Fire Code of New York State

1.6 SYSTEM DESCRIPTION

A. Prior to beginning work, review the existing sequence of operation. The existing sequence of operation shall be maintained.

B. All fire alarm pull stations and a/v units shall be red unless otherwise indicated including junction boxes, exposed back boxes, and cover plates.

C. Provide activation of necessary functions at the Fire Control Panel as directed by the particular elements in alarm or activated.

1.7 SUBMITTALS

A. Provide submittals for the entire system including:
   1. Provide a complete system test report of the existing system by a technician certified by the system manufacturer. Submittal shall include report for owner's reference.
   2. Complete equipment list including quantities.
   3. Riser Wiring Diagram showing all devices, wire quantities and sizes.
   4. Calculations, including actual equipment loads used to derive battery backup ampere-hour rating.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

A. Existing System: Simplex 4100ES FACP.

B. Provide additional expansion cards in existing fire alarm control panel as required. Expansion cards shall be of the same manufacture as the existing panel.

C. Provide all programming as required for installation of new devices and expansion cards.

D. Provide additional NAC power supplies as required for additional notification device loads.

E. System circuits shall be configured to match existing system.

2.2 INITIATION DEVICES

A. Provide additional expansion cards in existing fair alarm control panel as required. Expansion cards shall be of the same manufacture as the existing panel.

B. Provide initiation devices to match existing initiation devices. Field verify existing manufacturer and part numbers of devices prior to ordering.

C. Furnish Duct Smoke Detectors and sampling tubes. Provide remote test switches for all Duct mounted Smoke Detectors. Refer to plans for NEMA 3R Duct Smoke Detector types required. Coordinate final installations with HC.

2.3 OUTPUT DEVICES AND RELAYS

A. Provide output relays to match devices. Field verify existing manufacturer and part numbers of devices prior to ordering.

B. Visual notification device layout is based on 100 Candela-Second Zenon flash output. Provide additional devices as required to meet NFPA requirements.

C. Audible notification device layout is based on a rated 104 dB at 10 ft. Provide additional devices as required to meet NFPA requirements.

2.4 BATTERY AND CHARGER

A. Batteries shall be sized to allow the system to operate [24] hours under supervisory condition and at the end of this period to operate all alarm signals for fifteen consecutive minutes.

B. Provide additional/larger batteries and charger as required to accommodate any additional loads added as part of this renovation.

C. Batteries shall be lead-calcium type with cell reversal protection.

D. Life expectancy shall be ten years minimum.

E. Charger shall be self-regulating, solid state type, automatic with capability to fully charge the completely discharged battery within five hours.

F. Locate charger within the Fire Alarm Control Panel.

G. Design Make: match existing

2.5 FIRE ALARM CABLING

A. All wiring shall be twisted, copper. Wire must be certified for use by manufacturer. Wiring shall be sized as follows
   1. Minimum #16 AWG for station circuits
   2. Minimum #14 AWG for signal and detector circuits
   3. Minimum #12 AWG for power supply circuits.
   4. Provide large wire where required for voltage drop.

B. Wire must be plenum riser rated, red in color.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Refer to Division 1.

B. All installations shall be by qualified personnel regularly engaged in and experienced in this type of Work.

C. Detection and initiating equipment shall be listed by UL or approved by FM.

D. Key all new panels, manual pull stations, etc. to match existing.

3.2 INSTALLATION

A. Install audible and visual signal devices 6 feet 8 inches above floor.

B. Provide steel wire guards at all exterior notification devices as well as in gymnasiums, multipurpose rooms and locker rooms.

C. During installation and testing, and prior to the system being put into service, all manual stations shall be appropriately marked "NOT IN SERVICE" by the Contractor.

D. Wiring to all initiation and signal circuits shall be wired to match existing classification.

E. All wiring shall conform to N.E.C. Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".

F. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.

G. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.

H. Provide all wiring to post indicator valves and alarm check valves provided by others. Wire into the trouble mode of the fire alarm system.

I. Provide all wiring to the smoke dampers installed by others. Wire to the damper junction box with flexible conduit and wire; provide box or boxes as required. Install according to N.E.C. Article 300-22. Smoke dampers shall operate only when its associated smoke duct detector is in alarm.

J. Duct Smoke Detector Installation:
   1. Duct Smoke Detector furnished by Electrical Contractor. Coordinate sampling tube length with Mechanical Contractor.
   2. Mechanical Contractor to install Duct Smoke Detector in ductwork and seal air-tight.
   3. Electrical contractor to provide all required wring to connect Duct Smoke Detector to Fire Alarm system.

K. Wiring:
   1. Install all wiring in accordance with manufacturer's recommendations.
   2. All wiring shall be installed in EMT conduit in a separate and segregated system.
   3. Install all 120 volt wiring in separate conduit.
   4. All exposed wiring shall be installed in EMT conduit or surface raceway. Existing conduit if acceptable may be used. Fire rated cabling may be run above accessible ceilings. Cable in mechanical rooms, crawl spaces and exterior shall be run in conduit.
   5. All wiring not in conduits shall be plenum rated and fire rated and installed in a separate bridle ring raceway system, located on 4' centers.
   6. Wiring shall be continuous from device to device. Splicing shall be accomplished by use of terminal blocks in locked cabinets keyed alike with the fire alarm control unit, or junction boxes. No connections or splices shall be made underground.
   7. Control cabinets shall not be used as pull boxes or raceways. Wiring gutters and locked terminal cabinets shall be used.
   8. The Fire Alarm System wiring shall be installed in a workmanlike manner, subject to the approval of the project manager
   9. All harnessing of wires shall be accomplished by use of approved nylon tie wraps.
   10. All wiring shall be numbered and color coded in accordance with this Specification.

11. Tests of all wiring shall be conducted for proper connection, continuity, and resistance to ground. The minimum allowable resistance between any two conductors or between conductors and ground is one (1) megohm as checked by a "megger" after all conduit, conductors, detector bases, etc. have been installed, but before the detector devices are plugged into the base or end-of-line devices installed.

L. Routing:
1. All fire alarm system conduits shall be provided either parallel or perpendicular to building structural members.
2. All fire alarm system conduits shall be provided at a height so as not to obstruct any portion of a window, doorway, stairway, or a passageway, and shall not interfere with the operation of any existing mechanical or electrical equipment.
3. All fire alarm system conduits and cable shall be routed to minimize the potential for physical damage, either mechanical or by fire.
4. All fire alarm system junction boxes, pull boxes, terminal cabinets, control enclosures and device backboxes shall be readily accessible for testing, service and maintenance.

M. Mounting and Labeling of Devices:
1. All fire alarm devices shall be rigidly mounted, using appropriate backboxes, to building structural members, permanent walls, ceilings or fixtures designed for the purpose.
2. All devices shall be labeled with device address or device count as appropriate. Label shall be sticky back type attached to base of device. Label identification shall be consistent with As-Built drawings.

N. Color Coding and Wire Numbering:
1. All conductors entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner.
2. All conductors shall be color coded. Color coding shall be by wire insulation, not taping or banding. The numbering and color coding shall be continuous for each circuit wire.
3. Wire shall be coded and number to match existing coding and numbering schemes.
4. Wires shall be numbered at each connection, termination, and junction point. Wire numbering tags shall be Brady Perma-Code, Westline, or equal.

3.3 EXTRA PRODUCTS

A. Furnish (2) of each type (NEMA 1 and 3R) of Duct Smoke Detector and Remote Test Switch.

B. Additional work:
1. Contractor to include the cost to install the additional devices not shown in the contract documents:
   a. Furnish (2) Fan Shut-down relays.
   b. Furnish (2) NEMA 1 Duct Smoke Detectors and remote test switch.
   c. Cost to include installation of device, back box and 100 ft. of wiring for each device and programming.

3.4 INTERRUPTIONS TO EXISTING FIRE ALARM SYSTEM

A. Do not remove any portion of the existing fire alarm system from operation while installing new work without written approval of the Project Manager.

B. Student occupied spaces must have existing systems maintained during school operation.

C. In order to accomplish the above requirements, temporary wiring and relocations of some existing and/or new equipment may be necessary. These temporary locations should approved by the project manager and arranged so as to avoid safety problems.

3.5 TESTING

A. Prior to beginning work provide a complete system test by a technician certified by the system manufacturer. Report any existing problem conditions to the owner and Construction Manager.

B. After complete installation of the equipment and submittal of as-built drawings, the Contractor shall perform complete tests of the system. After these tests have been completed, the Contractor shall request final acceptance inspection and tests in the presence of the Project Manager and local authority. Coordination of final acceptance test date and times with those to be present is the responsibility of the Contractor. The Contractor shall demonstrate that all conditions of the plans and specifications have been met. The tests shall include proper operation of all devices and testing of supervised circuits. The installation will be checked against the as-built drawings. The Contractor shall furnish all testing materials and instruments. A punch list will be developed and the Contractor shall correct punch list items. There will be a reinspection of punch list items. If additional re-inspections are found necessary to assure compliance with the Contract, they shall be made at the Contractor's expense.

C. Final acceptance tests shall be coordinated by the contractor and performed in the presence of the owner's representative as follows:
   1. Operation of the fire alarm control panel and indicating components in accordance with factory recommended procedures.
   2. Operational tests of all devices (i.e., detector, waterflow indicator, manual pull box, and valve supervisory device) in accordance with the factory recommended procedures.
   3. Audible/visible testing of all indicating appliances. Tests shall include sound level (dBa) and light intensity (lumens).
   4. Checks of each initiating circuit or device address for correct indications at the control unit, and any remote annunciator. i.e. Operation of the S.T.U. including receipt of the appropriate zoned signal at the Palo Alto Communications Center.
   5. A checkout report shall be prepared by the contractor and submitted to the Project Manager. The checkout report shall include a listing of detector sensitivity for each detector. The report shall summarize the results of all tests and shall serve as the contractor's certification that the system is properly installed and fully functioning.

3.6 MANUFACTURER'S FIELD SERVICES

A. Include services of technician to supervise installation, adjustments, final connections, and system testing.

B. Prior to the final inspection, "pre-test" the entire fire alarm system to assure that all new equipment is properly installed and functions in accordance with plans and specifications.

C. The Manufacturer's representative shall certify that the entire new and existing installation was tested and performed satisfactorily.

3.7 DEMONSTRATION AND INSTRUCTION

A. Demonstrate normal and abnormal modes of operation, and required responses to each.

B. Provide a minimum of 4 hours of instruction to the operating personnel designated by the Owner's Representative with regard to use and operation of the system. Content of the training shall include:
   1. Overview of system operations.
   2. Overview of system equipment and device locations.
   3. Detailed operation guidelines.
   4. Periodic maintenance procedures.
   5. Periodic testing procedures

3.8 ZONE MAP

A. Provide updated Zone Map at each Fire Alarm Control Panel and at each Remote Annunciator.

B. General:
   1. Zone Maps shall show what areas of the building are covered by the system installed. Maps shall be accurate, legible, easily understood and reviewed with the Fire Department prior to submitting. Coordinate directly with the Fire Department when creating the Zone Map per contract.
   2. Descriptors identified on the Zone Maps must match the description of the device locations identified on the Fire Alarm Control Panel and Remote Annunciators. Fire Department personal should be able to see the information displayed on the Fire Alarm Control Panel and Remote Annunciators and be able to cross-reference that location with the Zone Map to know how to respond.
   3. As-built (record) drawings must be accurate and represent the current use of the space. When a building or system is modified, it is the responsibility of the contractor and Fire Alarm service provider who made modifications to the system to update these maps.

C. The requirements of the Zone Map shall be as follows:
   1. Zone Maps shall be framed and protected with plexi-glass.

2. Size of Zone Map shall be a minimum size of 8.5" x 11" for buildings 5000 sq. ft. or smaller, 11" x 17" for buildings 5001-10,000 sq. ft. and 22" x 24" for buildings 10,000+ sq. ft.
3. Coordinate directly with Fire Department and obtain approval on the zone layouts prior to submitting Zone Map.

D. Items that shall be included on the Zone Map:
1. Name and address of building or business.
2. Building layout with legible room names and numbers.
3. You are here symbol to orient Fire personnel with their location inside the building.
4. Location of Fire-Rated walls and their ratings (refer to Architectural plans).
5. North arrow.
6. Date when Zone Map was installed.
7. Fire Alarm Symbol Legend.
8. Fire Alarm Control Panel, NAC panel, Remote Annunciator and Knox Box locations.
9. Fire Alarm device locations with legible point identification for each initiating device that matches what is shown on the Fire Alarm Control Panel and Remote Annunciator.
10. Segregation, hash marks or shading to clearly indicate where (1) zone stops and another zone begins that matches what is shown on the Fire Alarm Control Panel and Remote Annunciator.

3.9 FIRE DOCUMENT BOX (FDB):

A. Provide updated documentation for Renovations and Modifications to the existing system. The updated documentation shall include:
1. A final copy of the record of completion shall be provided after completion of the operational acceptance tests.
2. Testing & Inspection reports.
3. Complete as-built drawings of the Fire Alarm System indicating signal initiating and signal circuits including as-built riser diagram indicating all address identification numbers.
4. Provide as-built floor plan drawing(s) indicating all cable routing pathways.
5. Provide as-built point to point interconnecting diagrams for the main console connections.
6. Operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
7. A copy of all site-specific software on USB drive.
8. A copy of the sequence of operation.

3.10 WARRANTY

A. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.

3.11 COMPLETION AND ACCEPTANCE

A. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance

B. Prior to request for final payment submit a quantity of bound Operator Manuals that shall include as a minimum:
   1. Shop drawings.
   2. Bill of Material.
   3. Manufacturer's equipment description for each piece of equipment, each device and each initiation and control module type used.
   4. Record Drawings for fire alarm wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, zones, and wiring requirements. Record Drawings for fire alarm wiring diagram shall show all terminal connections at all panels.
   5. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative.
   6. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved. (Both new and existing systems).
   7. One year warranty statement in accordance with the Basic Requirements Section of these specifications.
   8. Certificate of Completion as described in NFPA-72, Section 1-7.2.

END OF SECTION